THE NEW YORK AND BROOKLYN BRIDGE.

The figure on this page representing the cross section of the New York and Brooklyn Bridge, was prepared to accompany the Report which was anticipated from the Chief Engineer, in answer to a resolution of the Board of Trustees made at their last meeting, calling for information from him in reference to changes of plans of the superstructure of the bridge. The anticipated meeting of the Board has not taken place, but as a matter of interest to many of our readers at this time we insert the figure, which explains itself sufficiently, if it be understood that the original plan of the bridge looked only to the passage of ordinary cars, and the height of the main trusses (within which the Pullman cars are there shown) were then but 10 ft. high, on the line of *AA*, instead of 15 ft. as now. The foot-path was on the level of *BB*, and the side trusses were but 8 ft. 8 in., where they are now 10 ft. high, and the main lattice girders, now 2 ft. 8 in. in depth, were then plate girders of but 15 in. in depth. These and other minor changes will indicate the great additional stiffness which has been given to the platform of the bridge, and its consequent increased capacity for irregular loading at the expense of a few hundred additional tons of steel.

SPUYTEN DUYVIL DISASTER—THE VERDICT.

On the 25th inst., the Coroner's jury rendered the following verdict, which was delivered by the foreman, General Vielé:

"As to the responsibility for this calamity the jury find:

"*First*—That George Melius, the rear trainman of the Chicago Express train, was guilty of wilful, deliberate and culpable neglect in not going immediately to the rear of his train a sufficient distance to warn the approaching train, according to the rules of the company, which he had ample time to do; and that said George Melius is directly responsible for the loss of life that followed such neglect.

"*Second*—That George F. Hanford, conductor of the Chicago Express train, in not going in person immediately to the rear of the train to see that the rear trainman did his duty, and in not replacing the rear trainman by another trainman, as directed by the rules of the company, is responsible for the loss of life that followed such neglect of duty.

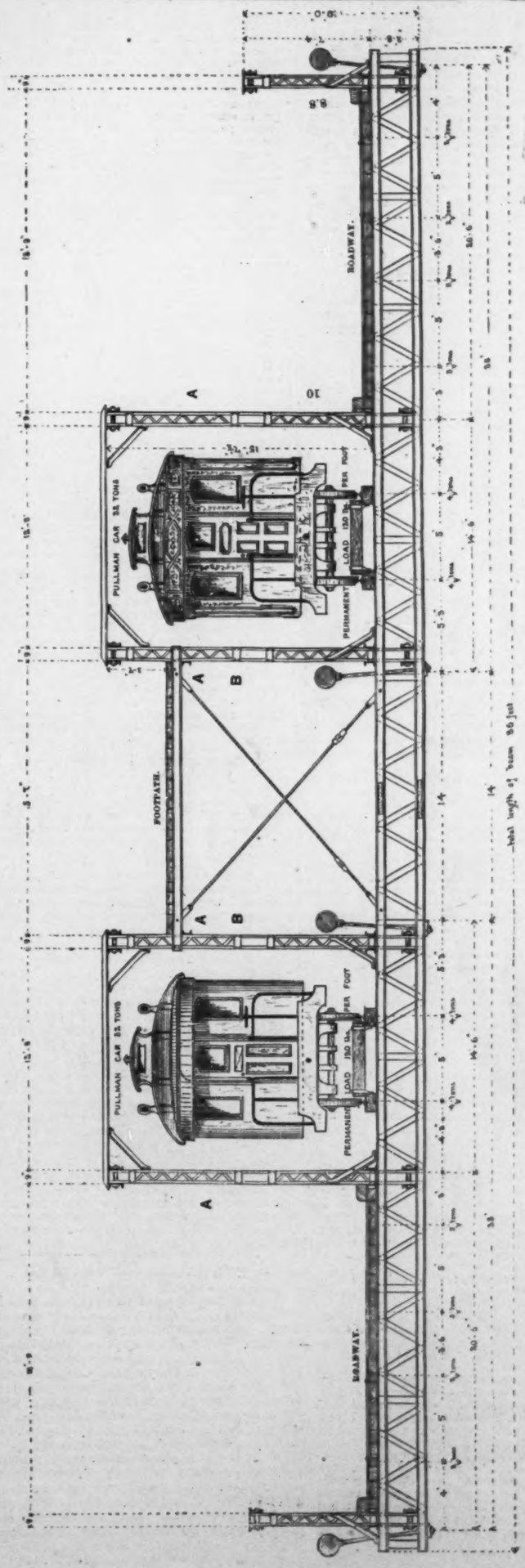
"*Third*—That Edward Stanford, engineman of the leading locomotive, in persistently endeavoring to draw the train after the brakes had been applied, neglected his duty and is responsible for the loss of life which followed such neglect of duty.

"*Fourth*—That Archibald Buchanan, engineman of the locomotive immediately attached to the Chicago Express train, in persistently endeavoring to draw the train after the brakes had been applied, and in neglecting to cut off the escape of air from the air-chamber on the locomotive as soon as the brakes were applied, thus depriving himself of the power to release the brakes, neglected his duty and is responsible for the loss of life that followed such neglect. That Frank Burr, engineman of the locomotive of the Tarrytown special train, neglected his duty in not keeping a proper lookout in passing from the Spuyten Duyvil cut, failing for this reason to see the signals of danger in time to check the speed of his train, and is responsible for the loss of life resulting from such neglect.

"*Fifth*—That John M. Toucey, Superintendent of the New York Central & Hudson River Railroad Company, in neglecting to provide efficient safeguards against accidents at the most dangerous part of the road—namely, the Spuyten Duyvil cut—and in formulating a schedule of time for the passage of trains that permitted a rate of twenty miles an hour on a sharp curve through a high, precipitous cut, in which it is impossible to see more than fifty feet ahead for a distance of 600 ft., is responsible for the loss of life which followed such neglect and such schedule.

"*Sixth*—That the officers and managers of the New York Central & Hudson River Railroad Company, in neglecting to provide suitable implements for the rescue of passengers in danger, and proper means for extinguishing fire on the trains, in not establishing the competency of their employés by proper mental and physical examinations to test their qualifications for the responsible and critical duties imposed upon them, are responsible for the loss of life that followed such neglect.

"The jury find that each and every one of the persons named is responsible in his own individuality, no one sharing the responsibility with another; and as a further expression of their opinion, the jury affirm that with their experience of fifty years in general management, and with the appliances in general use for the prevention of like disasters, there appears to be no palliation whatever for the criminal carlessness and disregard for


ROADWAY.
FOOTPATH.
ROADWAY.
PULLMAN CAR 32 TONS
PERMANENT LOAD 120 lbs. PER FOOT
PULLMAN CAR 32 TONS
PERMANENT LOAD 120 lbs. PER FOOT
A
B
A
B
A
A
10
8.8
15
14
14
14

human life exhibited by the employés of the company. The conduct of these employés removed this calamity from the chapter of accidents, making the result of destructive agencies at work as much a certainity as the discharge of a piece of artillery. The only surprise is that the slaughter was not greater; it could not well have been less.

"As a still further expression of their opinion on the evidence the jury deems it fitting to express their reprehension of the practice of the promiscuous distribution of free railroad passes during the session of the Legislature, believing it to be demoralizing in its tendency and an incentive to unseemly conduct by encouraging free excursions between the capital and the metropolis. The jury deem it their duty to urge the immediate and thorough protection of the whole line of the Spuyten Duyvil branch road at all the road and street crossings within the city limits.

"The jury regard the use of a cord attached to a valve of the air-brake in the passenger cars as attended with more elements of danger than safety, and as complicating the use of an already complicated appliance, believing that the strap running through the cars and connecting with the engine is a safer reliance against accidents.

"The jury regard the use of candles in lighting the cars to be attended with less danger than oil, and that they answer all necessary purposes. The jury further find that George Melius, George G. Hanford, Archibald Buchanan, Frank Burr, John M. Toucey and the New York Central & Hudson River Railroad Company are guilty of causing the death of Webster Wagner, Park Valentine, Louisa Valentine, Mary L. Brown, J. Albert Richards, Oliver P. Keeley, Francis Marechal and Darling L. Ransom, by criminal means and culpable negligence in the performance of their several duties connected with the said railroad company, in so far as by such inquisition the jury have been able to ascertain.

"Signed: Egbert L. Viele, Charles H. Haswell, John Payser, D. H. McAlpin, Henry J. Davison, L. E. Schnieder, W. H. Weightman, Henry Eichling, Francis J. Burke, Edward Haeuser, L. T. Howes, J. Teichman."

NEWSPAPER OPINIONS ON THE VERDICT.

The verdict of the Coroner's jury upon the Spuyten Duyvil disaster is so sweeping as to be absolutely worthless for any public purpose and entirely to defeat its own object, whether its object be public or private. The evidence showed plainly that the brakeman was guilty of gross negligence. The conductor cannot properly be said to have been guilty of negligence at all. He neglected nothing. He did what he supposed to be his duty, and went where he supposed himself to be most needed; and it now appears that he made a mistake. But the verdict in effect asks the public to believe that on a railroad managed with exceptional care and intelligence, on which accidents are very infrequent, two trains were entirely manned by reckless incompetents. The public will decline to believe anything of the kind. It is very well to summon experts on juries called to investigate disasters of this kind. But it ought to be ascertained first that the experts are men not merely of special knowledge but of common sense, and men who are capable of undertaking their work in something approaching a judicial frame of mind.—*N. Y. World.*

Responsibility for an accident may attach to a great many people. In the case of the Spuyten Duyvil accident it appears that the express train was stopped, not by the brakes getting out of order, as was first reported, but by some tipsy passenger tampering with them in the car closet, where means of putting them on is provided for use in case cause of stoppage should be known on the car and not on the locomotive. This person is presumed to be a member of the Legislature, who will probably interest himself in the laws proposed at Albany for preventing railroad accidents. But then the stopping of the train need not have caused an accident, and would not if the brakeman had done his duty and gone back with a danger signal, as the rules plainly prescribe; and so the brakeman is responsible. But probably the brakeman would have gone back far enough if the conductor had ordered him, as the rules prescribed (at least if he had watched him around the corner), and thus the conductor becomes responsible. But if this section of the road had been worked by the block system, as the section but a few miles from it is, then there would have been no approaching Tarrytown train south of Spuyten Duyvil to run into the express; and here we have the company responsible. And each and all are truly responsible.—*R. R. Gazette.*

It is evidently the opinion of the Coroner's jury in the Spuyten Duyvil case that somebody is to blame, though the sweeping generality of their inculpation of almost everybody mentioned in connection with the calamity seems to us likely to lead to about the same result as if they had found the ancient verdict of nobody to blame. They do find, in fact, that it is nobody in particular. It is the brakeman, the conductor, the two engine-drivers of the express, the engine-driver of the other train, Mr. Toucey and the officers and managers of the Hudson River Railroad Company—each of these as to some specific point. Mr. Toucey is held responsible for the loss of life on account of the way the time-table was made out; the company, because there was no implements, such as axes; the Tarrytown engineer, because he did not keep a good lookout, and so on. We are in favor of holding somebody to a distinct responsibility in a case like this; but we believe such a verdict defeats that end. It is held in one sentence that Melius is responsible for neglect of duty; but if the time-table was at fault that lightens, so far as it goes, the fault of Melius; and if Melius did not go far enough to the rear to warn the Tarrytown train, how is the Tarrytown engineer to blame for not seeing him? If he did go far enough to be seen by that engineer, how is he guilty? Both the engine men of the Chicago train are made responsible for the loss of life because they persistently endeavored to go ahead with the brakes applied; but was it the endeavor to go ahead that caused the disaster?—*N. Y. Herald.*

The verdict of the Coroner's jury in the Spuyten Duyvil disaster comes to prove the possible virtue of a system which long since fell into general discredit. It has of late come to be accepted that the Coroner's inquest will do little except to secure a recital under oath of facts long before gleaned by the active agents of the daily press. It is rarely that the readers of the morning papers within 24 hours of a murder or a railway accident do not know as much as after the Coroner has closed his investigation, and equally rarely that they cannot come to a sounder conclusion than is generally embodied in the verdict of the Coroner's jury. But in this case the jury was an exceptionally intelligent and clear-headed set of men; the testimony was very simple, direct and comprehensive, and the result is that a verdict is presented which fixes the responsibility in a manner not to be mistaken. The jury find that Melius, the rear trainman of the Chicago express, was responsible for not giving the proper signal to the Tarrytown train; Hanford, the conductor, for not seeing that the trainman did his duty; the engineers of the Chicago train for trying to draw the train after the brakes had been applied; the engineer of the Tarrytown train for not keeping a proper lookout; Toucey, the superintendent of the road, for neglecting efficient safeguards and for the rapid time required of trains in the Spuyten Duyvil cut, and, finally, the officers and managers of the road in neglecting proper means for the rescue of passengers and the extinguishing of fires, and in not sufficiently testing the competency of their employés. Had the directors and officers of the road made it plain that they regarded the safety of the passengers who had intrusted their lives to them as a consideration above and beyond all others, there could have been no such indifference to that consideration as was shown at Spuyten Duyvil, and as is shown every day of the year on some of the trains of this company. It is, therefore, especially desirable that the officers of the law into whose hands the matter now passes should pay particular attention to those who are highest in authority. We do not know how far the statutes impose penalties for such "neglect" resulting in loss of life as the jury distinctly charge upon the officers and managers of the New York & Hudson River Railroad, but it is essentially necessary that every possible means should be resorted to to bring these gentlemen to a strict account. If it were within the range of the capacity of the law that the more directly responsible of them could be made to see the inside of a prison, a sense of personal accountability would be awakened in the bosoms of all of their class which would add very much to the safety of the millions of railway passengers in our country.—*N. Y. Times.*

It is always desirable to have an emphatic and definite verdict; and in the present instance nobody can justly complain that such a one has not been rendered. We believe it is a long time since the officers and managers of a company have been so pointedly censured; and that those of the Hudson River Company have been thus rebuked, proves that the jury were both conscientious and courageous. Were there any hope of perfect justice being meted out to the parties upon whom this frightful responsibility is fixed, it would be gratifying to know in what that justice would consist. At any rate the conclusions to which the jury has arrived will give general satisfaction, excepting to the culprits themselves and their relatives and friends.—*Evening Telegram.*

MR. VANDERBILT'S FEELINGS.

Mr. Vanderbilt is said to have been greatly shocked by the terrible crash and slaughter on his railroad at Spuyten Duyvil. There was reason why he should. When all the truth comes out, if it ever does, it will be seen that the culpable brakeman, who was so promptly arrested, is not much more than a scapegoat. Economy in running the road was the primary cause of the horror. Had the flagman who was discharged some months ago, to save his paltry $1.50 a day, been retained at his post, the chances are ten to one that the horror would not have happened. A curious thing occurred yesterday at the District Attorney's office. It is part of the District Attorney's duty to keep an eye on the Coroner's inquiry. He was just about to send one of his assistants with the Coroner when a pass, good for one year over any of the Vanderbilt roads, was handed to him. It came from Mr. Vanderbilt's confidential man, Chauncey M. Depew. Mr. McKeon ordered its prompt return. He won't accept favors. If it were against the law for any official to accept a railroad pass, the railroad companies probably would not get off quite as easy as they do.—*Exchange.*

THE BAILEY FIRE HYDRANT.

The different kinds of fire hydrants now in general use may be divided into three classes, viz.: Those with valves opening with the pressure and current of water, those opening against the same, and gate hydrants. The one which we illustrate to-day belongs to the first class, and, commencing from the bottom, has the following parts: 1. The valve case where connection is made with the main, and containing the valve, drip and all vital parts of the hydrant. 2. The stand-pipe. 3. The stuffing-box plate. 4. The top or cover.

The valve is a piston-valve, closing on a flat, or beveled seat, as preferred. The bottom surface of the valve is hard leather, which, having stood the service of 8 years, is believed to be the best material for the work. The circular surface *D* of the piston is a split bronze ring *B*, fitting loosely on the inner parts of the valve, but springing and fitting closely in the bronze ring, which is driven tight into the valve case. Through the ring *B* in the case and the iron outside of it, there is a drip-hole, and when the valve is closed this drip-hole is uncovered and allows the water to run out of the stand-pipe; but as soon as the hydrant is opened *a quarter of an inch* the drip is closed, and as the water pressure gets within the split drip-ring the greater the pressure the tighter the drip.

FIG. 1. PERSPECTIVE.

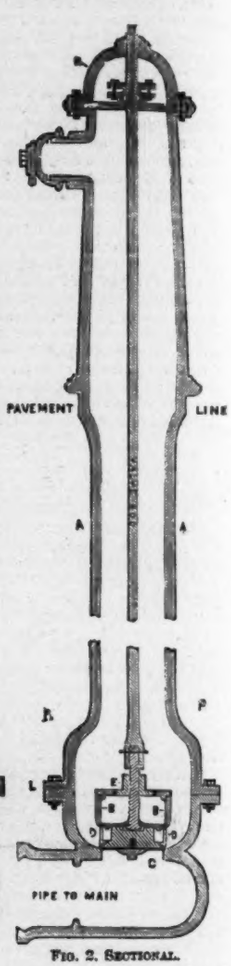
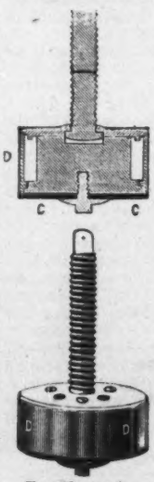


FIG. 2. SECTIONAL.



FIGS. 3 AND 4.

FIG. 5.

THE BAILEY FIRE HYDRANT.

The perfection of the drip is therefore perfectly positive and perfectly tight—even when the hydrant is open but ¼ in.—a somewhat new feature, since there are hydrants in which the drip is not closed until the valve is nearly wide open, and others where the drip is never closed, unless the pressure in the mains is sufficient to overcome a valve kept open by its own weight. Most of the hydrants used in New York City are provided with the gravity drips, and probably every one when in use is like a leak in a suction pipe. If the pressure is so little that the fire engines have to *suck* water through the hydrants they also

suck air through the drip valves. The valve in the hydrant here illustrated is operated directly by a short brass stem not over 6 in. long, which stem runs in a thread in the brass cap screwed into the top of the valve case, a prolongation of this stem runs into the cover as shown. The valve is shown is Figs. 3 and 4 and the cap *E* in the lower part of Fig. 2. When the valve is opened it rises into the chamber *BB*, sliding up within the brass ring lining said chamber. The water goes up each side as shown in Fig. 5, and passing the valve chamber the two currents unite in the stand-pipe. The area or capacity in the two side ports and stand-pipe is largely in excess of that of the supply-pipe.

In case it is necessary to remove the valve for examination or repairs, this can be done *by one man* and a new valve placed in position in 15 minutes. The cover and stuffing box plate are removed, a socket wrench with gas pipe stem is slipped down over the stem upon the cap in the valve case. This is unscrewed and the stem, cap and valve are all lifted out. This facility for repairs is somewhat in contrast with the use of 2 or 3 men, the gin poles, tackle blocks and levers, which may be seen when a hydrant which unscrews at the base is used. In that case the stand-pipe, weighing several hundred pounds and extending from 4 to 5 ft. below the surface, has to be lifted out, which is more than 1 man can do.

Should the stand-pipe here be broken in any way it does not injure the valve at all or cause it to leak, but a new stand-pipe can be put in place without shutting off the water in the main.

The positive action of the valve and drip, and the ease with which repairs can be made if necessary, commend themselves.

The makers are the Mohawk & Hudson Manufacturing Co., of Waterford, N. Y., who make the Eddy valve also.

CORRESPONDENCE.

THE BEST STUMP-PULLER.

CINCINNATI, Jan. 24, 1882.

EDITOR ENGINEERING NEWS:

Permit me to answer Mr. Fisk's query as to the "best stump-puller" by recommending, for ease, simplicity, thorough work and economy, cartridges of Hercules powder or dynamite.

Take a crowbar, and with it make a hole under the stump large enough to insert a cartridge. Shove the cartridge in, fire the fuse, and retire. The result will be eminently satisfactory. Very refractory stumps may call for two cartridges, but one will usually suffice.

In 1879, during the convention of the American Society of Civil Engineers in Cleveland, I witnessed this method of stump extraction at the factory of the Hercules Powder Co. I was greatly impressed with its advantages, and am glad to have an opportunity of calling attention to it. W. E. M.

ALIGNMENT OF COMPLETED RAILROADS.

BACKWOODS, Canada, Jan. 3, 1882.

EDITOR ENGINEERING NEWS:

I undertake to furnish your correspondent with a method by means of which he can take up the alignment of a railway, the records of which have been lost. Along the straight portions a couple of trials will fix his line for him; by taking the center of his embankment in a number of places, he will, upon prolonging any one set of them, soon hit upon a mean. For curves see "Henck's Field Book for Engineers," page 58, prob. 79; or if he has any case where the intersection angle cannot be found, take a few points as *A B C*, 100 feet apart, measure the deflection angle to them, and a few trials will show him where the center line ought to be; he has then his deflection angle and chord, from which the radius of the curve can be found.

For, let D = deflection angle,
C = chord,
B = radius,

Then $R = \frac{\frac{c}{2}}{\sin. D.}$

Yours, etc., L. L. P.

THE DENVER & NEW ORLEANS RAILROAD.

PUEBLO, COL., Jan. 16, 1882.

EDITOR ENGINEERING NEWS:

The first party on surveys for the Denver & New Orleans Railroad left Denver on March 18 last under my charge. Since that time many lines and miles of preliminaries have been run; the road located from Denver to this point, about 190 miles, and the earthwork done, with the exception of a little within the city limits of Pueblo. The track is laid out 50 miles from Denver, and bridge-building and track-laying progressing fairly for winter work. If not too much impeded on the Colorado Divide, *i. e.*, between the drainage of the Platte and Arkansas rivers, by heavy snows, the track will probably be laid to this point by April 1. My assistants on construction of the Arkansas River Division have been Mr. E. R. Howe, Mr. S. W. West and Mr. Thomas W. Titcomb. In my party on location south of this point are Mr. A. M. Gibson, transitman; Mr. R. G. Withers, levelman, and Mr. John F. Taylor, Compassman. Mr. W. J. Smith has been in charge of preliminary surveys south of the Arkansas since April last, and is now on the Cimarron, or between that stream and the Canadian River.

The company have opened a fine vein of coal on their property, about 12 miles east of Colorado Springs, and about 4 miles from the main line, the coal branch being very direct, with moderate grades all in the direction of the loaded trains.

With the fervent hope that the NEWS "may live long and prosper," I remain

Yours truly, JOHN S. TITCOMB,
Division and Locating Engineer.

SELF-READING LEVEL RODS.

MINNEAPOLIS & ST. LOUIS RAILWAY,
ENGINEERING DEPARTMENT.
IN CAMP, Dec. 26, 1881.

EDITOR ENGINEERING NEWS:

I have noticed the several designs for self-reading level rods that have been illustrated in the NEWS, and I send you an illustration showing the form designed and used on this road. The advantage of this style consists in the figures being formed of straight lines entirely, and the centre of the figure making the tenth, the top and bottom of the figures show the half-tenths at a glance. This, together with the fact that the thickness of the figures, for the tenths, is one hundredth, reduces the necessity of counting, to determine the hundredths at turning points, to a minimum. The facility of reading will be seen by a slight examination of the diagram. The figures 1 and 2 are to be red on the rods for greater distinctness. In practice our levelers read these rods easily at 1,000 feet, the shape of the figures helping not only to make reading at a distance easy but also doing away with errors through getting figures confused by wrong reading.

It is seen that these rods are adapted to the use of a target if desired, and it is our practice to use a target on turning points, and thus check the level reading.

The plan and elevation show the construction, which does not differ materially from the usual form for self-reading rods.

Respectfully,
GEO. L. WILSON.

[Some time since we published accounts of two self-reading level rods which were in use, and had many earnest advocates of their efficiency. We now present the third. Our readers can form their own estimates of the relative merits of each.]

THE STANDARD METRIC CHAIN.

PROVIDENCE, R. I., Jan. 20, 1882.

EDITOR ENGINEERING NEWS:

Several communications have recently appeared in your columns concerning the use of the metric system in civil engineering, from which it appears that a great diversity exists in the application of the system, already resulting in much confusion; and the question is asked, What should be the length of the standard metric chain?

The object of all operations involving the use of the metric system is to measure quantity in terms of some one of a certain series of units of measure which are decimally related to one another, and to do this in the simplest manner.

A standard series of measures has been adopted for the measurement of quantities of different magnitudes, by which the measurement is performed without any unnecessary use of fractions, and therefore in the simplest manner. The measures of this series are determined by the following general principles:

I. A measure may consist of a single metric unit of length, capacity or weight, or may be a multiple of some such unit.

II. Each multiple measure shall consist of a whole number of the metric unit next smaller than itself. Consequently, each multiple measure may be expressed in terms of every metric unit smaller than itself without the use of fractions.

III. Each multiple measure shall be competent to measure without the use of fractions, the metric unit next larger than itself, and consequently every metric unit larger than itself.

Since the successive metric units are related to each other by a ten-fold ratio, it follows that every multiple measure must consist of either two or five metric units next smaller than itself, and the complete series of measures, whether of length, capacity or weight, consists of the metric units themselves, together with the half and double of each.

It should always be kept in mind, however, that quantity should never be stated in terms of the multiple measure, but always in terms of the metric units; the multiple measures being only intended to simplify the mechanical process of measuring.

The series of standard linear measures is shown in the following tables:

THE STANDARD METRIC MEASURES OF LENGTH.

NAME.	Length in meters.	REMARKS.
Half-decimeter.....	0.05	Used by machinists and others on small work. Edges are divided into millimeters and fifths, millimeters and halves, or millimeters. The numbering is in centimeters.
Decimeter.....	0.10	Ditto.
Double-decimeter ..	0.20	Ditto.
Half-meter.....	0.50	A convenient measure for carpenters and others on bench work. Divided to millimeters and numbered in centimeters.
Meter.....	1.00	Made in various forms and suitable for a great variety of uses. Divided to millimeters or centimeters and halves, or centimeters. Usually numbered in centimeters.
Double-meter.....	2.00	A convenient rod or tape for measuring objects of moderate size. Divided and numbered like the meter.
Half-dekameter	5.00	A rod or tape for measuring objects of larger size. Seldom used.
Dekameter.....	10.00	Tape or chain for land surveying and civil-engineering. The chain has *five* links to the meter, and is marked at each meter.
Double-dekameter..	20.00	Ditto. Better adapted for measuring smooth land. The chain has *five* links to the meter, or 100 links altogether, and is marked at each meter.

Similar tables, showing the standard metric weights and capacity measures, exist, but are foreign to the purpose of this communication.

This series of standard measures was adopted many years ago, and is used in France and other metric countries. In France it is prescribed by law.

A chain of 25 meters violates the second general principle, inasmuch as its length is $2\frac{1}{2}$ *dekameters*; 25 being a more complex number than 20, it is intrinsically a less convenient implement to use.

A chain of 30 meters violates the third general principle, since it is impossible to lay off a hektometer or kilometer by means of it without an annoying use of fractions.

The Gunter 4-rod chain is widely known, and is extensively used in civil engineering and land-surveying both in this country and in England. Its length, which is $20\frac{10}{100}$ meters, shows that the 20-meter chain is by no means unsuited to field work on account of its absolute length.

When using the 20-meter chain it should be constantly borne in mind that the terms "chain" and "link" have no significance in the metric system, except as designating an implement and its parts. They are never used to indicate units of length.

It should also be remembered that the chain and its links are each double units, and that distances should never be expressed in terms of them, but always in terms of some metric unit.

With such a chain the stations of a railroad would naturally be placed 20 meters apart. The numbering of the stations and the record kept of the survey should be of such a character that the distance between any two points may always be obtained by a single subtraction. This may be done by marking upon the stakes their distance from the initial point either in *meters* or in *dekameters*. Either method is entirely legitimate; but it is important that one or the other should be adopted uniformly.

Fewer figures are required when the stakes are marked in *dekameters*, and this method seems to the writer to be more in keeping with the habits of thought of the American engineer.

Upon ordinary ground the stations would be marked with the even numbers, as 0, 2, 4, 6, 8, 10, etc., the hektometers appearing as multiples of 10, and the kilometers as multiples of 100. Upon rough ground the stakes would be set 10 meters apart, and the numbering would embrace all the numbers, as 11, 12, 13, 14, etc. Fractional stations would seldom be required in cross-sectioning.

The two methods of marking the stakes are contrasted in the following table:

Distance of each station from the initial point in meters.	Marking of the Stakes.	
	Method in meters.	Method in dekameters.
5,720.00	5,720.00	572
5,740.00	5,740.00	574
5,760.00	5,760.00	576
5,780.00	5,780.00	578
5,800.00	5,800.00	580.
5,810.00	5,810.00	581
5,820.00	5,820.00	582
5,825.64	5,825.64	582+5.64

The unnecessary complication caused by the use of the 25 meter chain and an imperfect system of numbering the stations on some of the Mexican railways, has already been illustrated in your columns, and requires no further comment.

CHARLES H. SWAN, C. E.,
Chairman Metric Bureau Committee on Manufactures.

THE METRIC SYSTEM FOR RAILROADS.

NEW YORK, Jan. 12, 1882.

EDITOR ENGINEERING NEWS:

I notice in Mr. Lowe's communication relative to the use of the Metric System on the Mexican Railroad, page 3, of the 7th inst., that a chain 25 meters long is used and every meter is marked with a tag with the appropriate numbers stamped thereon, and that some of the chains have 125 links each, two decimeters long, while others have 100 links each, 2.5 decimeters long; also that the plus distance is given in meters, thus 28 + 12 means 28 stations plus 12 meters, the total distance equals 712 meters. Now in view of the fact that many valuable tables in our field books for engineers are based on a chain having 100 units of length, it would be more convenient to use a chain, whatever its length may be, of 100 links, and to mark every ten links with a tag, the same as in the 100-foot chain, and then note all, plus distance by the number of links the distance measures. The foregoing example, 28+12, would be noted as 28+48 or 28.48; the 12 meters would come at the forty-eighth link, and $\frac{2848}{4}$ = 712 meters, same as before. A chain of 20 meters would be convenient, particularly in estimating earth-work from average end areas (estimating earth-work from average end areas instead of the prismoidal formula is a common practise among engineers); take, for example, the following field-notes for an embankment with a road-bed of 4 meters, slope 1½ to 1. I have assumed the road-bed to be 4 meters for the reason that if the metric system were in use in this country the width of a single track road-bed would generally be, in all probability:

For embankment, 4 meters = 13.12 ft.,
" excavation (earth), 6 meters = 19.68 ft.

These numbers, 4 and 6, are handy ones to use in calculating end areas of cross-sections where the center and two side heights and the distance out are given, as in the following notes:

Road-bed, 4 meters. Slope, 1½ to 1.
Length of station, 20 meters.

Stations.	Left.	Center.	Right.	Embankment.	
				Sq. meter.	Cu. meter.
24	−4.10 / 8.15	−2.24	−3.16 / 6.74	23.94	... .
25	−3.94 / 7.91	1.18	−2.92 / 6.38	15.29	392.3
26	−1.24 / 3.86	−2.14	2.18 / 5.27	13.19	74.0

For example take the cross-section at station 24 and apply the old rule, viz:

Add the two side heights and multiply by one-fourth the road-bed (in this case one-fourth the road-bed is unity) (4.10+1.16)×1=7.26 sq. meters, then multiply the sum of the distance out by half the centre height $(8.15+6.74)\times\frac{2.24}{2}=16.68$ (the nearest hundredth), and add the two results together, 16.68+7.26=23.94 sq. meters, the total area for this station. Having calculated the areas for the three cross-sections, we now proceed to obtain the cubic meters. Add the areas for stations 24 and 25 and put the sum in the column *cubic meters*, moving the decimal point one figure to the right, in like manner add the areas for 25 and 26 and multiply the same by .26 and place the result in the column of cubic meter. Now, if instead of a 20 meter chain, one of 25 meters had been used, then we should increase the amounts in the cubic meter column by one-fourth.

In comparing the number of figures and in calculating cross-section areas where hundredths are used in the metric system and tenths in the foot, it will be found that for distances ranging from 1 ft. to 3.28 ft. and from 10 ft. to 32.8 ft. the same number of figures will be used in either system, but from 0 to 1 ft. and from 3.28 to 10 ft. more figures will be used in the metric system.

In curvature let us consider the chain to subtend on the chord an angle of 1° for a 1° curve, the same as in the foot system, then the radius would equal 5,730 links instead of that many feet, and if the chain is 20 meters long, then each link equals 2 meters and 5,730 links equal 1,146 meters.

20 meters = 65.6 ft., = ⅔ of 100, nearly.
Let M° = curvature in the metric system.
and F° = " " " foot "
Then will the following formulas give a close approximate of the relative value of the two systems:

$$F^\circ = 1\tfrac{1}{2}\ M^\circ$$
$$M^\circ = \tfrac{2}{3}\ F^\circ$$

For instance if 6° is the maximum curvature allowed in the foot system, then its equivalent in the metric system would be ⅔ × 6° = 4°.

In conclusion, I will state that if the metric chain has 100 links, and we consider each link in the light of a foot, we may use in connection with it, and with equal facility, the many valuable tables that have been constructed for the 100-foot chain; and here I may state that a most excellent table has been devised for the use of the locating engineer by Wm. F. Shunk, and is to be found in his new book, "The Field Engineer;" it gives the lengths of chords, versed senis, external secant and tangent for a 1° curve for every even minute up to 90°. I have used this table for the past six months on location, and know from experience it is of great value, and I think it can be used just as readily in the metric system, in the manner suggested, as in the foot system.

Respectfully, JOHN WATERHOUSE.

ASPHALT PAVING — ITS CLEANLINESS, CHEAPNESS AND COMFORTABLENESS.

[From the Philadelphia Record, Jan. 19, 1882.]

WASHINGTON, D. C., June 7, 1881.—H. W. Pitkin, Esq., Chairman of the sub-committee of the Executive Committee of One Hundred, Philadelphia, Pa.—Dear Sir: I have had the honor to receive your letter of the 4th instant, making inquiries in regard to the asphalt pavements of this city, and to reply:

First. As to comparative first cost of asphalt and granite-block street pavements.

Granite-block pavements laid in 1880 in this city cost $1.79 per square yard. Those laid in 1879 $1.92 per square yard.

Asphalt pavements laid here in 1880 cost $1.85 per square yard. In 1879 cost $1.47 per square yard.

Second. Annual costs of repairs of the asphalt pavement on Pennsylvania avenue, the principal street of Washington, has been for the Neufchatel pavement 2½ cents per square yard. For that laid on same street by other contractors, 1½ cents per square yard. These pavements have been in use now about 4 years.

Other bituminous concrete pavements of various kinds, principally coal tar, have been laid in this city since 1871 to the extent of 741,000 square yards. Their average annual repairs have cost 8½ cents per square yard. They are not so good or durable as the asphalt pavements laid in the last four years.

Macadam pavements in Paris are being diminished in extent, being replaced by others less expensive in maintenance. They are not liked here, except for the suburbs, where there is little heavy travel. They cost for repairs on the most traveled streets $1.93 per square yard. The average annual cost for repairs is 37 cents per square yard.

Paris stone block pavements are made of sandstone; cost $2.58 to $3.23 per square yard for construction and 10½ cents per square yard per annum for repairs.

Asphalt pavements in Paris cost per square yard $2.17 to $3.22 and per year for repairs and replacing each year $\frac{1}{11}$ of the pavements laid 22 cents per square yard.

There is more asphalt and bituminous concrete pavement in this city than in any city in the world. It was introduced at first in many streets against strong prejudices of the dwellers on such streets. Stone pavements, wooden pavements and Macadam pavements were preferred, and were laid to a great extent.

Now, the city authorities lay down any other than an asphalt pavement only when compelled by economy, which, in some cases, prescribes the use of Macadam or gravel and stone blocks where traffic is believed to be too heavy for the asphalt; and they find the residents of such streets wherever anything but asphalt is laid down making vigorous protests against their operations.

Since 1871 there have been laid here of wood pavements 1,188,597 square yards, costing $4,003,744, and covering 50 miles of streets.

On the 1st of July, 1880, there remained in the city only 509,481 square yards of this wood pavement, most of it impassable without danger to wheels and springs.

The city contained on 1st July, 1880, of concrete unfaced with asphalt or coal tar:

	Miles.
Pavements	40.66
Stone block	14.87
Rough stone	18 04
Macadam	7.45
Gravel	31.31
Wood	22.10
Unimproved streets	95.62
Total	230.05

I have no doubt that the wear and tear of horses and carriages on a good asphalt pavement, such as that of Pennsylvania avenue, in this city, is very much less than on any other pavement in use here.

I think a carriage used on mud roads will last ten times as long as if used on the streets of Philadelphia, with which I am familiar, having lived there from infancy to manhood, and having in visits of late years found no improvement, but rather a worse condition than existed 50 years ago in that city.

Third. The asphalt would, in my opinion, certainly answer for all your streets not subjected to heavy traffic. But as this heavy traffic—and it is very heavy in Philadelphia—will abandon all the cobble pavements to seek the newly asphalted streets for the sake of the easier draught, the freedom from jolting and the greater comfort for horse and man, I do not see how this traffic can be kept off any principal street in Philadelphia. I think that the first street asphalted will be crowded at once, and that the heavily-loaded vehicles will drive off the light pleasure traffic.

In your narrower streets, alleys, and in all streets which, like many of those in Philadelphia, do not follow continuous lines, but are offset at many street crossings, the asphalt will give you a clean, wholesome pavement. Every summer shower washes its surface perfectly clean, and if the fall is good cleans even the gutters. Used on those streets and in alleys it will be a great economy and have a great sanitary influence.

I have lived and ridden and driven in this city during the execution of all its street improvements. There is no comparison in comfort between any other pavement and one of asphalt for those who ride or drive either in light carriages or in heavy loaded carts and wagons and for the residents on the streets, and I am of opinion that while the cost of repair of asphalt under heavy traffic would be much greater than such cost in this city at present; that considering the saving in cleanliness, comfort and health to man, and the saving in cost of horseflesh and of repairs of wheels and springs, it will be worth while to lay down a strong asphalt surfaced concrete payment for your heaviest traffic, and to compare its first cost and its actual annual cost for repairs and *renewal* with the cost and duration of your present street pavements, and that it is probable that taking into account the saving of horseflesh, of wear and tear of all vehicles and of body and mind, it will be found best to adopt the asphalt pavements generally.

It will be necessary to make frequent renewals of the wearing surface, but this is cheap. Any Philadelphia block, laid on a good foundation of concrete thick enough not to give way under the weight of loaded truck wheels, can be resurfaced in twenty-four hours, and by doing the work at night I believe that it can be done without stopping the daily commerce of the streets.

Here the usual foundation is six inches of concrete of hydraulic cement, sand and broken stone. Possibly in Philadelphia there may be streets which would need twelve inches of such foundation, well set before being opened to traffic. But in the end I believe this would be fully worth its cost.

I have just obtained a proof of the annual report of Lieutenant F. V. Greene, United States Corps of Engineers, from which most of the figures and quantities in this letter are quoted. It is probably the very best, as it is the most recent, paper on the subject of these pavements.

I am, very respectfully, your obedient servant,

M. C. MEIGS,
Quartermaster General, Brevet Major Gen. U. S. A.

TEXAS PINERIES.—The long-leaved pine area in Texas is located in the eastern portion of the State, commencing about 50 miles from the Gulf of Mexico. The short-leaved loblolla and yellow-pine area, with oak and other hardwood timber mixed, lies west of the long-leaved pine region, extending from 50 miles north of Galveston northward to the Red River, about 350 miles long by 100 to 120 miles wide. The region from which merchantable pine has been taken along the margin of some of the streams is comparatively insignificant, showing that the lumber trade of the Lone Star State is in its earliest infancy, and will be something immense in future years of manhood, when 67,000,000,000 of merchantable pine lumber shall have been stripped from her soil.

LIST OF WATER-WORKS

IN THE UNITED STATES AND CANADA, AS FAR AS KNOWN, JANUARY, 1882.

The first List of Water-Works was published by J. J. R. Croes, C. E., in 1876, for the Centennial Commission of the American Society of Civil Engineers. In 1877 to 1881 Edward Prince, C. E., of Quincy, Illinois, published several editions of revised Lists, compiled by him by great perseverance. This List is based upon his last one, with such corrections and additions as have been discovered during the past year. There are no water-works in several towns included in former lists.

Private enterprises are marked thus *.

ALABAMA:
Birmingham,*
Huntsville,
Jacksonville,
Mobile,*
Montgomery.*

ARIZONA:
Prescott,
Tombstone.*

ARKANSAS:
Little Rock.*

CALIFORNIA:
Anaheimo,
Columbia,
Dutch Flat,
Gilroy,*
Grass Valley,
Los Angeles,*
Marysville,*
Modesto,
Mission San Jose,
Nevada City,
Oakland,*
Petaluma,*
Placerville,
Red Bluff,
Sacramento,
Santa Barbara,*
San Francisco,*
San Jose,*
San Quinlan,
San Rafael,*
Salinas City,
San Diego,
Stockton,
Santa Cruz,
Vallejo,*
Watsonville,
Washington, Yolo Co.,
Woodford, Yolo Co.,
Yreka.

COLORADO:
Bodie,
Boulder,
Caribou,
Canon City,*
Central City,*
Colorado Springs,*
Denver,*
Fair Play,
Golden,
Gunnison,
Leadville,*
Pueblo,
Silver Cliff,
Silver City,
Trinidad.*

CONNECTICUT:
Ansonia,*
Bethel,
Birmingham,*
Bridgeport,*
Danbury,
Greenwich,
Hartford,
Meriden,
Middletown,
Milford,
New Britain,
New Haven,*
New London,
New Milford,
Norwalk,
Norwich,
Rockville,*
South Norwalk,
Stamford,*
Stonington,
Wolcottville,*
Waterbury,
Winsted.

DAKOTA TERR.:
Deadwood,
Fargo.

DELAWARE:
Dover,
New Castle,*
Wilmington.

DISTRICT OF COLUMBIA:
Washington.

FLORIDA:
Jacksonville.

GEORGIA:
Atlanta,
Augusta,
Columbus,
Macon,*
Rome,
Savannah.

IDAHO TERRITORY:
Silver City.

ILLINOIS:
Alton,*
Bloomington,
Cairo,
Charleston,
Chicago,
Decatur,
De Kalb,
Dixon,
Elgin,
El Paso,
Evanston,
Hyde Park,
Jacksonville,
Joliet,
Lakeview,
Litchfield,
Moline,
Oregon,
Paris,
Pekin,
Peoria,
Quincy,*
Riverside,
Rockford,
Rock Island,
Springfield,
Sterling,
Sycamore,
Waukegan.

INDIANA:
Attica,
Brasil,
Brookville,
Columbus,
Connersville,
Evansville,
Fort Wayne,
Indianapolis,*
Kokomo,
LaFayette,
Laporte,
Logansport,
Madison,
Marion,
Michawakee,
New Albany,*
New Carlisle,
Peru,
South Bend,
Terre Haute,*
Union City,
Vincennes,
Washington.

IOWA:
Anamosa,*
Atlantic,
Burlington,*
Cedar Rapids,
Clinton,*
Council Bluffs,*
Davenport,*
Decorah,
Des Moines,*
Dubuque,*
Fort Dodge,
Keokuk,*
Lyons,*
Marengo,
Marshalltown,
Monticello,
Mt. Pleasant,
Muscatine,*
Oskaloosa,
Ottumwa,*
State Centre.

KANSAS:
Abilene,
Atchison,
Blue Rapids,
Emporia,
Topeka.

KENTUCKY:
Bowling Green,
Covington,
Frankfort,
Henderson,
Louisville,*
Maysville,
Newport,
Owensboro,
Pleasant Hill.

LOUISIANA:
New Orleans.*

MAINE:
Auburn,*
Augusta,*
Bangor,
Biddeford,*
Houlton,
Lewiston,
Portland,*
Rockland,*
Waterville.

MARYLAND:
Annapolis,*
Baltimore,
Cumberland,*
Frederick,
Frostburg,
Hagerstown,
Morganza.

MASSACHUSETTS:
Adams,
Agawam,*
Amherst,
Arlington,
Athol,*
Attleboro,
Beverly,
Boston,
Brighton,
Brockton,
Brookline,
Cambridge,
Charlestown,
Cheshire,
Chicopee,*
Chicopee Falls,
Concord,
Danvers,
Dedham,
East Hampton,
East Saugus,
Everett,
Fall River,
Fitchburg,
Gardner,*
Great Barrington,*
Greenfield,
Greenville,
Haverhill,*
Hingham,*
Holyoke,
Kingston,*
Lawrence,
Lee,
Lenox,*

MASSACHUSETTS:
Leominster,
Lincoln,
Lowell,
Lynn,
Malden,
Medford,
Melrose,
Methuen,
Marblehead,
Middleboro,
Milford,
Natick,
Nantucket,*
New Bedford,
Newton,
North Adams,
North Bridge,
Northampton,
Orange,*
Peabody,
Pittsfield,
Plymouth,
Reading,
Salem,
Shelburn Falls,
Somerville,
South Adams,
So. Hadley Falls,
South Lee,*
Springfield,
Stockbridge,*
Taunton,
Warren,
Waltham,
Wakefield,*
Westborough,
West Brookfield,*
Westfield,
West Springfield,*
Winchester,
Woburn,
Worcester.

MICHIGAN:
Allegan,
Alpena,
Ann Arbor,
Bay City,
Big Rapids,
Cadillac,
Constantine,
Detroit,
East Saginaw,
Grand Haven,
Grand Rapids,
Holly,
Ionia,
Jackson,
Kalamazoo,
Marquette,
Muskegon,
Niles,*
Plainfield,
Plainwell,
Port Huron,
Portland,
Saginaw,
St. Louis,
Tecumseh,
West Bay City.

MINNESOTA:
Mankato,
Minneapolis,
St. Paul,*
Stillwater,
Winona.

MISSISSIPPI:
Columbus.

MISSOURI:
Carthage,
Hannibal,*
Kansas City,*
Sedalia,
St. Joseph,*
St. Charles,*
St. Louis,
Joplin.

NEBRASKA:
Omaha,*
Nebraska City,
Grand Island.

NEVADA:
Austin City,
Eureka,*
Gunnison,*
Gold Hill,*
Hamilton,
Pioche,*
Virginia City.*

NEW HAMPSHIRE:
Bethlehem,
Claremont,*
Concord,
Dover* (3 co.'s),
Farmington,
Great Falls,
Keene,
Manchester,
Nashua,*
Plymouth,
Portsmouth.*

NEW JERSEY:
Bergen,
Bloomfield,
Bridgeton,
Bordentown,*
Burlington,
Camden,
Cape May,
Elizabeth,*
Flemington,
Hackensack,*

NEW JERSEY:
Hackettstown,
Hoboken,*
Jersey City,
Lambertville,*
Long Branch,
Millville,*
Morristown,*
Mt. Holly,*
Newark,
New Brunswick,
Passaic,*
Paterson,*
Perth Amboy,*
Rahway,
Salem,
Trenton.

NEW YORK:
Albany,
Amsterdam,
Andes,
Attica,
Auburn,*
Avon,*
Ballston Spa,
Batavia,
Bayside,
Binghamton,
Brooklyn,
Buffalo,
Canajoharie,
Chateaugay,
Cohoes,
College Point,
Cooperstown,*
Corning,*
Dansville,
Delhi,*
Dunkirk,*
Edgewater,
Ellenville,
Elmira,*
Flushing,
Flatbush,
Fort Edward,*
Fredonia,*
Garden City,*
Geneseo,
Geneva,*
Glens Falls,
Gloversville,
Goshen,
Gouverneur,*
Hudson,
Ithaca,*
Jamestown,*
Johnstown,
Kingston,
Leroy,
Lockport,*
Long Island City,
Lyons,
Malone,
Medina,
Middletown,
Newburg,
New Brighton,
New Hartford,
New York City,
Niagara Falls,*
Norwich,
Ogdensburg,
Oswego,*
Owego,*
Peekskill,
Port Byron,
Port Jervis,*
Port Richmond,
Potsdam,
Poughkeepsie,
Prospect Park,
Plattsburgh,
Richfield Springs,
Rochester,
Rome,
Saratoga Springs,
Schenectady,*
Suspension Bridge,
Susquehanna,
Syracuse,*
Tarrytown,
Tonawanda,
Troy,
Utica,*
Walton,*
Whitehall,
Warwick,
Warsaw,*
Watertown,
Waverly,
West Troy,*
Yonkers.

NORTH CAROLINA:
Fayetteville,
Wilmington,*
Salem.

OHIO:
Akron,*
Alliance,
Bellaire,
Bellevue,
Canton,
Cincinnati,
Cleveland,
Columbus,
Crestline,
Dayton,
East Liverpool,
Elyria,
Findley,
Galion,
Hamilton,
Ironton,
Lancaster,

OHIO:
Lagona,
Mansfield,
Massillon,*
Middletown,
New Lisbon,
Norwalk,
Piqua,
Portsmouth,
Salem,
Sandusky,
Sidney,
Springfield,
Steubenville,
Tiffin,
Toledo,
Urbana,*
Wadsworth,
Wellsville,
West Cleveland,
Wooster,
Youngstown,
Zanesville.

OREGON:
Portland,*
Salem,
The Dalles.

PENNSYLVANIA:
Allegheny,
Allentown,
Altoona,
Archbald,*
Ashland,
Beaver Falls,*
Bradford,
Bedford,
Bellefonte,
Bethlehem* (2 co.'s),
Berwick,*
Birmingham,
Bloomsburg,
Blairsville,
Boyerstown,
Bristol,*
Butler,
Carbondale,
Carlisle,*
Catasauqua,
Chambersburg,
Chester,
Clarion,
Coatesville,
Columbia,*
Connemaugh,
Conshohocken,*
Corry,
Crawfordsville,
Danville,
Downingtown,*
Doylestown,
Dunmore,
Easton,*
Ebensburg,
Ephrata,
Erie,
Franklin,*
Germantown,
Gettysburg,
Hamorton,
Hanover,
Harrisburg,
Hazelton,*
Hollidaysburg,
Honesdale,
Huntington,
Jamestown,
Johnstown,*
Kennett Square,
Kittanning,
Lancaster,
Lansford,*
Lebanon,*
Lewistown,
Lockhaven,
Louella,*
Mahanoy City,*
Mauch Chunk,*
Meadville,*
Mechanicsburg,
McKeesport,
Media,
Milford,*
Minersville,*
Monongahela,
Mt. Joy,
New Brighton,
Norristown,*
Oil City,
Oxford,
Parker City,
Philadelphia,
Phœnixville,
Pittston,*
Pittsburgh,
Plymouth,*
Pottstown,*
Pottsville,*
Providence,*
Reading,
Renovo,
Reynoldsville,
Salem,
Sewickley,
Scranton,*
Shamokin,*
Sharon,
Shenandoah,
Slatington,
South Bethlehem,*
Stroudsburg,*
Summit Hill,*
Susquehauna,*
Tamaqua,
Tioga,

PENNSYLVANIA:
Titusville,
Towanda,
Tunkhannock,*
Tyrone,
Westchester,
West Pittston,
Wilkes Barre* (2 Cos.),
Williamsport* (2 Cos.),
York,
Youghiogheny.*

RHODE ISLAND:
Bristol,
Central Falls,
East Providence,
Newport,*
Pawtucket,
Providence.

SOUTH CAROLINA:
Charleston,
Columbia.*

TENNESSEE:
Chattanooga,*
Clarksville,*
Columbia,
Knoxville,
Memphis,*
Nashville.

TEXAS:
Austin,*
Dallas,*
Dennison,
Galveston,
Houston,
San Antonio,*
Sherman,
Waco.*

UTAH:
Salt Lake City.
Park City,
Logan City.

VERMONT:
Bellows Falls,
Brandon,
Burlington,
Fair Haven,
Hyde Park,*
Rutland,
St. Albans,
St. Johnsbury,
Vergennes,
Windsor,
Worcester.

VIRGINIA:
Alexandria,*
Danville,*
Fredericksburg,
Lexington,
Lynchburg,
Norfolk,
Petersburg,
Richmond,
Staunton,
University of Virginia,
Winchester.

WASHINGTON TERRITORY:
Olympia,
Seattle,
Vancouver,
Walla Walla.*

WEST VIRGINIA:
Martinsburg,
Parkersburg,
Wheeling.

WISCONSIN:
Beloit,
Fond du Lac,
Janesville,
Kenosha,
La Crosse,
Madison,
Milwaukee,
Prairie du Chien,
Racine,*
Sparta.

CANADA:
Barrie,
Berthier,
Brampton,
Brantford,*
Clifton,*
Collingwood,
Dundas,*
East London,
Goderich,
Guelph,
Halifax, N. S.,
Hamilton,
Kingston,
London,
Mitchell,
Montreal,
Ottawa,
Owen Sound,
Parkdale,
Quebec,
Sarnia,
Seaforth,
Sorel,
St. Catharines,
St. Cunegonde,
St. Gabriel,
St. Thomas,
St. John, N. B.
Sherbrooke,
Three Rivers,
Toronto,
Truro,
Walkertown,
Windsor,
Winnipeg,
Wingham,
Woodbridge,
Yorkville,
Yarmouth,

STATISTICS OF 11 TOWNS SUPPLIED BY PUMPING INTO STAND-PIPE.

Name of Town.	State.	Index to Engineering News.			Population.	First Water-Works Built.	Present Works Begun.	Cost.	Remarks.	Bonded Debt.	Year of Returns.	Daily Average Consumption in Gallons.	Yearly Cost of Maintenance.	Yearly Revenue.	Miles of Pipe.	No. of Taps.	No. of Fire Hydrants.	Head in Feet.	No. of Meters.	Ownership.
		Index No.	Date.	Page.	1880.															
Chicago	Ill.	iv	March 26	122	503,304	1840	1854	$8,802,725.10		$3,955,000.00	1880	57,384,376	$248,907.07	$920,785.16	455.4	67,949	3,361	101.5	2,113	City.
New Orleans	La	x	April 23	163	216,140	1836	1879	2,324,382.16		320,000.00	April, 1881	8,947,229	54,951.73	95,937.20	15.5	11,268	1,250	60.0		Company.
Toledo	Ohio	xlix	July 30	305	50,143	1873	1880	1,145,476.62	Including interest.		Dec. 31, 1880	3,262,000	20,777.35	28,919.18	46.87	1,616	349	260.0	85	City.
Charleston	S. C.	li	Aug. 6	311	49,999	1824	1880			400,000.00		200,000			15			90.0		Company.
Fall River	Mass.	xxix	July 2	264	49,006	1870		1,514,438.67	Except interest.	1,700,000.00	Dec. 31, 1880	1,357,349	15,526.62	114,706.38	52.05	2,685	587	180.0	1,583	City.
Savannah	Ga	cxxxvii	Nov. 12	459	30,681	1854		300,000.00		198,000.00	Dec. 31, 1880	2,400,000	11,000.00	32,000.00	22.00		257	130.0		City.
Augusta	Ga	cxxxviii	Nov. 19	468	23,023	1828	1859	361,432.00			Dec. 31, 1880	2,400,000	6,786.85	10,833.23	21.61	1,650		106.3		City.
Bloomington	Ill.	cxlix	Dec. 3	488	17,184	1875		122,000.00		75,000.00	Dec. 31, 1880	400,000	5,426.60	7,613.91	12.5	475	150	235.0		City.
Sandusky	Ohio	l	July 30	305	15,838	1875		385,905.50			Dec. 31, 1880	1,290,000	12,621.53	13,020.01	20.4	969	146	220.0		City.
South Bend	Ind.	cxxiv	Oct. 29	433	13,279	1873	1880	225,000.00			Dec. 31, 1880	1,000,000	3,500.00	5,000.00	19.5	600	185	204.0	25	City.
Clinton	Iowa.	cxxix	Nov. 5	447	9,068	1874		120,000.00	To 1876.		1878	500,000	5,000.00		8.5	300	85	125.0		Company.

STATISTICS OF 44 TOWNS SUPPLIED BY DIRECT PUMPING.

Name of Town.	State.	Index to Engineering News.			Population.	First Water-Works Built.	Present Works Begun.	Cost.	Remarks.	Bonded Debt.	Year of Returns.	Daily Average Consumption in Gallons.	Yearly Cost of Maintenance.	Yearly Revenue.	Miles of Pipe.	No. of Taps.	No. of Fire Hydrants.	Presure in lbs., ordinary and fire	No. of Meters.	Ownership.
		Index No.	Date.	Page.	1880.															
Indianapolis	Ind.	xxii	June 4	227	75,074	1870		$1,200,000.00		$500,000.00	1880	3,000,000	$66,018.77	$75,064.49	43	1,200	601	45—100	12	Company.
Columbus	Ohio.	lxv	Aug. 12	329	51,665	1870		884,867.27	Includ. maint. & repairs		Mar. 31, 1880	2,159,327	19,544.92	44,572.47	39.5	2,156	319	50—100	534	City.
Minneapolis	Minn	cxxi	Oct. 29	433	46,887	1867		404,237.59	Construction only.		Mar. 31, 1880	3,010,591	14,849.87	20,818.51	18	1,119	256		20	City.
Dayton	Ohio.	xlviii	July 30	304	38,677	1869		705,917.80		555,000.00	Dec. 31, 1880	1,058,737	20,483.73	19,644 72	32.5	1,211	286		18	City.
Denver	Col.	cxxxix	Nov. 19	469	35,630	1871		600,000.00		350,000.00	1877	2,125,000	16,719.99	50,046.32	30	2,500	250	50—100	10	Company.
Atlanta	Ga	lxxvii	Aug. 27	342	34,398	1875		344,000.00			1877	1,122,400	14,001.00	10,217.55	12.4	614	193	50—100		City.
Memphis	Tenn.	clix	Dec. 17	509	33,593	1872		472,278.39	First works.	100,000.00	1880	5,000,000	25,000.00	45,000.00	20.0	3,000	200			Company.
Peoria	Ill.	cxlviii	Dec. 3	488	29,315	1869		450,000.00		450,000.00	1880	2,000,000	18,988.00	24,805.14	43	1,645	267	60—140	6	City.
Norfolk	Va.	lxx	Aug. 20	333	27,730	1872		531,618.75	Sept. 30, 1880.	500,000.00	June 30, 1881	707,934	12,740.58	29,922.77	23	2,200	117		40	City.
Fort Wayne	Ind.	cv	Oct. 8	406	26,880	1880		218,028.63		270,000.00	May, 1881	535,000	2,757.22	2,040.53	26	200	206			City.
Terre Haute	Ind.	lii	Aug. 6	312	26,040	1871		301,169.35			1880	820,000			19.5		376			Company.
Des Moines	Iowa.	cxix	Oct. 22	425	22,696	1871		388,618.39	Includes int. and maint.		Dec., 1880	1,300,000		26,263.83	20		190			Company.
Ottawa	Ca.	xxxiv	July 16	285	22,000	1872		914,000.00			1881	3,292,000	13,901.58	92,592.66	42.94	5,656	332	85—100		City.
Auburn	N. Y.	cviii	Oct. 15	413	21,934	1864		300,000.00			1881	2,600,000			26	200	253			Company.
Taunton	Mass.	liii	Aug. 6	312	21,213	1876		276,876.18			Dec., 1879	394,061			27.5	681	239		182	City.
Bay City	Mich.	xxxvii	July 16	287	20,653	1872		365,658.58		377,000.00	Dec. 31, 1880		70,365.95	74,073.18	19.5	845	138			City.
Burlington	Iowa.	lxxviii	Aug. 27	342	19,450	1877		254,390.71	Includes maintenance.		Dec. 31, 1879	302,170		9,075.80	17.41	561	199		27	Company.
East Saginaw	Mich.	cxli	Nov. 19	469	19,016	1873		360,314.62			1880	1,584,457	8,571.01	9,560.65	21.85	875	149		5	City.
Yonkers	N. Y.	lxxxi	Aug. 27	342	18,892	1873		669,299.66	Construction.		Dec. 31, 1880	900,000	9,462.78	15,995.21	23	750	246		402	City.
Binghamton	N. Y.	lxxiii	Aug. 20	333	17,315	1873		200,000.00		191,000.00	Dec. 31, 1880	1,700,000	18,209.93	28,984.36	23.8	2,360	171	40—60	5	City.
Bangor	Me.	xcii	Oct. 1	393	16,857	1868		500,000.00		425,000.00	Mar., 1881	1,015,484	7,753.75	25,855.87	23.7	1,358	155			City.
Jackson	Mich.	cl	Dec. 3	489	16,105	1875		180,000.00		140,000.00	1880	800,000	7,008.90	8,250.92	13	182	76		4	City.
Lockport	N. Y.	clxiii	Dec. 17	510	13,522	1870					1880	800,000			7	250	133			Holly Co.
Rockford	Ill.	clxxi	Jan. 7	6	13,139	1868		280,070.48			1880	900,000	5,791.76	7,273.38	27	1,000	190	57½—110		City.
Keokuk	Iowa.	clxxiv	Jan. 14	14	12,117	1878		102,000.00			1880	550,000			11.12	450	76			Company.
Kalamazoo	Mich.	lvi	Aug. 6	312	11,937	1875		168,673.53			Dec. 31, 1880	803,468	6,857.71	5,194.32	15.9	573	147			City.
Jacksonville	Fla.	cxi	Oct. 15	413	10,929	1869		98,000.00			1880				8	200	100		156	City.
Saratoga Springs	N. Y.	xc	Sept. 24	382	10,882	1873		250,000.00	Original cost.	232,000.00	Mar., 1880	780,000 W 1,600,000 S	7,458.57	25,378.32	17.2	1,346	133			Village.
Ogdensburgh	N. Y.	xcvi	Oct. 1	393	10,340	1870		150,000.00	1876.		1876	800,000	2,500.00		14	800	78			City.
Port Huron	Ohio.	clvii	Dec. 17	509	10,000	1868		180,000.00		150,000.00	1880	500,254	5,982.82	9,080.12	19	1,037	109			City.
Decatur	Ill.	clxii	Dec. 17	510	9,499	1873		145,000.00			Feb., 1880	250,000	6,553.26	7,483.91	9.58	385	91			City.
Stillwater	Mich.	cix	Oct. 15	413	9,054	1871		200,000.00	Cap. stock, $100,000		1880	1,500,000	2,430.00	3,642.00	7.5	129	87			Company.
Ironton	Ohio.	clxiv	Dec. 17	510	9,000	1880		160,000.00			1880	1,500,000	7,500.00	10,000.00	8		114			City.
Danville	Pa.	cxxxv	Nov. 12	459	7,790	1870		164,690.92			1880	360,000	4,500.00		10.1	815	94			Town.
Rahway	N. J.	cxiv	Oct. 15	414	6,430	1872		185,000.00	To 1876.		1876				9		125			City.
Mankato	Minn.	lxvi	Aug. 13	329	6,000	1871		16,046.47			1879				3		30	40		
Marshalltown	Iowa.	lxxi	Aug. 20	333	6,000	1877		179,829.17			Dec. 31, 1880		34,629.05	18,058.88	7.9	360	69			Town.
Norwalk	Ohio.	xci	Sept. 24	382	5,831	1870		174,710.40	Cap. stock, $30,000.		1880	523,696	4,384.45	4,133.73	14	354	84			City.
Niagara Falls	N. Y.	cxxi	Nov. 5	447	5,048	1877		29,995.18	Cap. stock, $30,000.		1876	500,000	2,333.93	3,932.37	5	340	34			Company.
Columbus	Ind.	cvii	Oct. 8	407	4,827	1870		52,000.00	1876.		1876	Not known.			4	180	52			City.
Evanston	Ill.	clxvii	Dec. 24	520	4,820	1874		40,000.00	1876.		1879	300,000	4,500.00		12	400	80			City.
Beaver Falls	Pa.	xcix	Oct. 1	393	4,327	1875		30,000.00	1876.		1879	30,000	1,000.00		6		32			Company.
Paris	Ill.	lxxiv	Aug. 20	333	3,500	1879					1880				6.5		56			City.
Potsdam	N. Y.	c	Oct. 1	394	3,500	1871		50,000.00			1877		550.00		4.5	140	35			Village.

STATISTICS OF 73 TOWNS SUPPLIED BY PUMPING INTO RESERVOIRS.

Name of Town.	State.	Index to Engineering News.			Popu-lation.	First Water-works built.	Present Works begun.	Cost.	Remarks.	Bonded Debt.	Year of Re-turns.	Daily Aver-ave Consump-tion in Gallons.	Yearly cost of Maintenance.	Yearly Reve-nue.	Miles of Pipe.	No. of Taps.	No. of Fire Hydrants.	Head in Feet.	No. of Meters.	Ownership.
		Index No.	Date.	Page.	1880.															
Philadelphia	Pa.	ii	March 12	102	846,984	1800		$19,184,957.27			Dec. 31, 1880	60,000,000	$270,589.88	$1,441,555.46	746	110,000	5,883			City.
Brooklyn	N. Y.	iii	March 19	114	566,689	1856				$11,379,500.00	Dec. 31, 1880	30,750,000	272,321.07	1,157,674.22	350	60,000	2,874		1,085	City.
St. Louis	Mo.	vi	April 9	142	350,522	1830	1871	9,126,000.00			April, 1881	25,124,000	224,981.72	660,000.00	212.04	20,264	1,856		980	City.
Cincinnati	Ohio.	viii	April 16.	153	256,708	1820		6,778,847.55	Const. only.	1,625,000.00	Dec. 31, 1880	19,476,739	186,527.90	499,857.36	188.86	23,627	900		863	City.
Cleveland	Ohio.	xi	April 23.	163	160,142	1853	1874.	2,820,514.12	Including interest.	1,200,000.00	Dec. 31, 1880	10,170,461	55,914.89	202,347.12	125.6	10,013	998	140.0	402	City.
Pittsburgh	Pa.	xxv	June 11.	234	156,381	1824		1,627,860.12	* Old works.		Jan. 31, 1880	16,000,000	129,883.11	400,000.00	112.5		770			City.
Buffalo	N. Y.	xii	April 30.	173	155,137	1852		3,050,000.00		2,950,000.00		16,530,000	60,000.00	210,350.00	102.1	9,099				City.
Montreal	Can.	xviii	May 21.	203	145,000	1801	1873				Dec. 31, 1880	11,640,000	60,381.14	366,474.81	132.8	31,309	866		305	City.
Newark	N. J.	xiv	May 7	183	136,400	1800		2,671,580.40		3,240,000.00	Dec. 31, 1880	9,390,000	68,682.92	312,749.55	136.2	10,905	1,186		150	City.
Louisville	Ky.	xv	May 7	183	123,645	1856		3,225,368.02		876,000.00	Dec. 31, 1879	5,500,000	40,056.61	176,097.45	110	7,225	339 c. 19 h.		251	City.
Jersey City	N. J.	xx	June 4	226	120,728	1852		4,950,000.00		4,838,000.00	Dec. 31, 1880	14,956,710	129,000.00	450,000.00	323		1,487	161.5	220	City.
Detroit	Mich.	xvi	May 14.	193	116,342	1824		2,750,700.39		1,503,000.00	Dec. 31, 1880	15,172,036	45,732.35	380,683.93	209	22,465	174 c. 747 h		29	City.
Milwaukee	Wis.	xix	May 21.	203	115,578	1872		1,851,591.03		1,600,000.00	Dec. 31, 1879	10,603,867	54,805.11	129,505.41	96.3	6,835	673	150		City.
Providence	R. I.	xvii	May 14.	195	101,255	1870		4,701,680.93			Nov. 5, 1880.	3,110,000	57,868.65	48,690.94	152	9,691	1,137		4,086	City.
Toronto	Can.	xxxi	July 9	271	80,000	1841		2,000,000.00				4,660,000	50,557.00	107,000.00	111.29	8,563	1,070	216	95	City.
Allegheny	Pa.	xxvi	June 18.	243	78,681	1847		1,100,000.00			1879	3,000,000	35,000.00	135,000.00	55		625			City.
Richmond	Va.	xxx	July 2	264	63,803	1830		2,500,000.00	Including maint.		1880	5,814,279	30,000.00	76,485.55	60	6,200				City.
Lowell	Mass.	xxiv	June 11.	234	59,485	1870					Dec. 31, 1880	2,254,197			62.97	12,198	672		708	City.
Troy	N. Y.	xxxii	July 16.	283	56,757	1829		926,082.16	Entire cost.	300,000.00	Dec. 31, 1880		39,281.00	74,477.35	42.9		400			City.
Kansas City	Mo.	xxvii	July 25.	263	55,813	1873									27		280			Company.
Cambridge	Mass.	xxviii	July 25.	264	52,740	1855		1,864,755.31		1,528,500.00	Dec. 1, 1880	2,423,220				7,322	579		156	City.
Syracuse	N. Y.	lxxxii	Sept. 10.	364	51,791	1829		650,000.00			1880	4,500,000	13,000.00	56,000.00	45		320			Company.
Paterson	N. J.	cxxxiv	Nov. 12.	459	50,887	1856						6,000,000			35	2,400	500			Company.
Nashville	Tenn.	cliv	Dec. 10.	503	43,461	1833		1,500,000.00		75,000.00	1880	6,000,000	65,667.93	64,541.42	42					City.
Wilmington	Del.	lxxxviii	Sept. 17.	372	42,499	1803		450,000.00			Dec., 1880	3,564,858	18,000.00	68,404.23	51.65	4,344	470			City.
Lawrence	Mass.	xxxv	July 16.	287	39,178	1873		1,791,835.14	Includ. int. and main.		1879	1,456,209	28,411.90	62,134.69	40.7	7,001	461		121	City.
Lynn	Mass.	xxxix	July 23.	293	38,284	1871		1,084,234.85		921,500.00	Dec. 31, 1880	1,238,289			57.28	4,488	411		2	City.
Hamilton	Can.	lxxxvii	Sept. 17.	372	35,000	1859		945,353.38		991,878.36	Dec. 31, 1880	1,800,000	27,628.56	99,729.07	65.00	8,200	438		280	City.
Manchester	N. H.	xxxvi	July 16.	287	32,630	1872		860,572.66			Dec. 31, 1880	1,180,930	113,870.54	157,655.35	33.24	1,807	307			City.
Grand Rapids	Mich.	xl	July 23.	294	32,015	1840		404,396.01			Dec. 31, 1880	1,107,427	9,417.11	15,157.48	22.28	819	235			City.
Omaha	Neb.	clxxv	Jan. 14	14	30,518	1881		400,000.00			1881	350,000			32	700	255			Company.
Elisabeth	N. J.	cxxii	Oct. 29.	433	28,229	1852		500,000.00					30,000.00		40.00		200			Company.
Erie	Pa.	lxxi	Aug. 20.	333	27,730	1867		607,311.00		675,000.00	Dec. 31, 1880	2,125,494	13,394.45	38,413.47	35.00	132	92			City.
Salem	Mass.	xliv	July 30.	303	27,598	1807		1,338,755.48			1879	1,940,000		50,629.74	85		343		117	City.
New Bedford	Mass.	lix	Aug. 13	327	26,875	1865		1,204,533.87	Entire cost.	700,000.00	Dec. 1, 1880	2,014,200	14,483.67	39,644.48	42.27	3,798	295		22	City.
Oswego	N. Y.	cxiv	Nov. 26.	480	21,117	1868											175			Company.
London	Can.	lxi	Aug. 13.	328	21,000	1878		390,000.00	Including interest.		Dec. 31, 1880	1,250,000			36		200			City.
Newport	Ky.	xlv	July 30.	304	20,433	1871		780,781.11	Including repairs.	700,000.00	Dec. 31, 1880		13,238.39	21,861.39	20.45	1,577	110		16	City.
Poughkeepsie	N. Y.	lviii	Aug. 6.	313	20,207	1870		602,545.59	1874.		Dec. 31, 1880	1,403,292	18,626.85	19,379.30	16.2	1,326	286		122	City.
Pawtucket	R. I.	lxxv	Aug. 20.	333	19,030	1877		641,799.10			Feb. 1, 1880	8,000,000	6,122.38	34,080.54	65.1	2,043	471		1,065	City.
Zanesville	Ohio.	cxliv	Nov. 26.	480	18,120	1842		500,000.00		300,000.00	Dec. 31, 1880	1,947,000	17,200.65	28,897.31	33.81	2,388	154	185	6	City.
Allentown	Pa.	cliii	Dec. 3.	489	18,063	1827		189,054.76		135,622.00	Dec. 31, 1880	1,000,000	3,403.68	16,438.75	18	2,400	95		18	City.
Newton	Mass.	liv	Aug. 6.	312	16,995	1875		854,937.73			Dec. 31, 1880	468,476	9,758.70	33,734.58	60.3	1,937	324		467	City.
Montgomery	Ala.	lxiii	Aug. 13.	329	16,714	1873						1,000,000			10	550	103			Company.
Akron	Ohio.	clv	Oct. 10	503	16,512	1880		250,000.00	Capital stock.	200,000.00					20	600	157		10	Company.
New Albany	Ind.	lxii	Aug. 13.	328	16,422	1875		200,000.00		100,000.00	Dec. 31, 1880	800,000		25,000.00	16	750	147			Company.
Lynchburgh	Va.	lxxxix	Sept. 17.	373	15,959	1799	1828	222,481.66			Dec. 31, 1880	1,250,000	6,841.37	12,337.05	13	750	131			City.
Newport	R. I.	clxxii	Jan. 7	6	15,693	1875		500,000.00	Capital stock.		1880	500,000			30	1,160	157		27	Company.
Chester	Pa.	xxiii	Oct. 1	393	14,996	1867		79,000.00	Original cost.		1875 & 1878		5,000.00	26,000.00	12	1,100	75			South Ward
Norristown	Pa.	clxxiii	Jan. 7	6	13,863	1847		275,000.00		90,000.00	1880	800,000			27	2,500	85			Company.
Nashua	N. H.	cxiii	Oct. 29.	433	13,397	1855		225,000.00	Const. and maint.		1880	1,000,000	10,000.00	30,000.00	23	1,600	75	132		Company.
Rome	N. Y.	xciv	Oct. 1	393	12,045	1873		165,000.00			1878		3,000.00	9,000.00	15	400	100			City.
Alexandria	Va.	lv	Aug. 6.	312	11,937	1851					1879		4,241.07	14,630.63						Company.
Waltham	Mass.	clxi	Dec. 17.	509	11,711	1873		305,722.13			Dec. 31, 1880	411,000	4,984.39	25,132.86	23.33		130			City.
Jacksonville	Ill.	cxi	Oct. 15.	413	10,929	1873		159,000.00	1876.		1876	225,000	3,500.00		9	200	70			City.
Alton	Ill.	civ	Oct. 8.	406	9,500	1875		105,000.00			Dec. 31, 1880	200,000	3,600.00		13	100	95		50	Company.
Meadville	Pa.	cxxxiii	Nov. 12.	448	9,000	1874		145,000.00	Capital stock, 125,000		Nov., 1881	280,000	3,153.79	25,448.44	15.5	806	100			Company.
Bridgeton	N. J.	clxx	Dec. 31		8,722	1877		79,070.00		76,000.00	Dec. 31, 1880	108,308	1,494.81	6,393.36	10.6	392	72			City.
Hudson	N. Y.	xlii	July 23.	294	8,669	1874		256,000.00			1879	938,187	7,645.12		12.5		176			City.
Muscatine	Iowa.	cxiii	Oct. 15.	414	8,294	1875		39,500.00	1876.		1878				3.5		40			Company.
Bellaire	Ohio.	cii	Oct. 1	394	8,000	1872		112,000.00	1877.		1878		5,000.00		6.75			165		Town.
Sherbrooke	Can.	cxlvi	Nov. 26.	481	7,000	1880-1		150,000.00			1880				4		75			Company.
Peekskill	N. Y.	lxxvi	Aug. 27.	341	6,893	1875		136,300.00			Dec. 31, 1880	180,000	1,826.16	3,361.49	10.33	371	84			City.
Phœnixville	Pa.	lxxxv	Sept. 10.	365	6,692	1873		200,000.00			Dec. 31, 1880	354,000	7,588.41	19,068.06	10.6	1,200	100			Town.
Conshohocken	Pa.	cvi	Oct. 8	406	4,800	1879		76,000.00			1876				4.26	200	40			Company.
Rome	Ga.	xcv	Oct. 1	393	4,374	1871		165,000.00			1878		3,000.00	9,000.00	15	400	100			City.
Birmingham	Ala.	xcviii	Oct. 1	393	4,050	1872		66,500.00	1876.		1876	1880, 100,000	1,200.00		6.50	200	15			Company,
Lyons	Iowa.	cxxx	Nov. 5	447	4,000	1876		40,000.00			1880	50,500	1,400.00	3 600.00	2	150	30			Company.
Anamosa	Iowa.	cxlii	Nov. 19.	469	2,500	1875		20,000.00			1880	24,600	1876, 700.00	1,643.00	1.3		7			Company.
Mt. Joy	Pa.	cxvi	Oct. 15.	414	2,063	1878		35,000.00	1877.		1877				3.7		23			Town.
Tioga	Pa.	cxv	Oct. 15.	414	1,200	1874		16,000.00	1877.		1877	40,000	250.00		3	120	14			Company.
Lincoln	Mass.	clviii	Dec. 17.	509	907	1875		33,000.00		30,000.00	1880		500.00		3.5	23	11			Town.
Pleasant Hill	Ky.	ciii	Oct. 1	394	300	1872						1,000								Company.

STATISTICS OF 47 TOWNS SUPPLIED BY GR V

Name of Town.	State.	Index to Engineering News. Index No.	Date.	Page.	Population. 1880.	First Water-works built.	Present Works begun.	Cost.	Remarks.	Bonded Debt.	Year of Returns.	Daily Average Consumption in Gallons.	Yearly cost of Maintenance	Yearly Revenue.	Miles of Pipe.	No. of Taps.	No. of Fire Hydrants.	No. of Meters.	Ownership.
New York	N. Y.	i.	March 5.	91	1,206,590	1799	1842	$69,326,697.18	Inc. int. and maint.	$15,505,000.00	1881	95,000,000	$347,438.95	$1,623,501.65	510	80,000	3,400	5,500	City.
Boston	Mass	v.	April 2.	131	412,000	1846		18,374,766.94	Exc. of int. and maint.	12,784,273.38	May 1, 1881.	35,900,000	312,938.45	1,365,200.69	500	69,504	4,039	1,631	City.
Baltimore	Md	vii.	April 16	151	332,190	1808		10,029,734.17		9,000,000.00	1880.		87,419.31	606,879.06	277.86	49,000		524	City.
San Francisco	Cal.	ix.	April 23	163	233,956	1857		8,746,928.12			1875	80-17,000,000	300,000.00		220.00				Company.
Washington	D. C.	xvii.	April 30	174	147,307	1864		5,500,000.00	1875. Cost and maint.		1880	26,000,000	82,686.08		175	17,000			U. S. Govt.
Albany	N. Y.	xxi.	June 4.	226	90,903	1813	1830–1878.				1879	5,000,000	57,353.23	96,295.37	77.33	2,832	493	10	City.
Rochester	N. Y.	xxiii.	June 11.	233	89,366	1873		3,500,000.00		3,000,000.00	April, 1881	5,000,000	39,155.97	74,660.39	112.8	7,588	979	100	City.
New Haven	Conn.	lxxxvi.	Sept. 17.	372	62,882	1860		843,591.55		325,000.00	1877				102	4,904	362	54	Company.
Worcester	Mass	xxxii.	July 9.	272	58,295	1798	1865	801,362.23	Construction only.		1880	3,500,000	15,124.37	84,325.80	79.94	5,300	633	3,791	City.
Quebec	Can.	clii.	Dec. 10.	503	60,000	1833		1,300,000.00		1,300,000.00	1880.	3,000,000	10,000.00	90,000.00	27.5	5,016	222		City.
Hartford	Conn	xxxviii.	July 23.	293	42,553	1854	1865	1,487,408.25		1,052,000.00	1880.	4,500,000			70.6	4,904	362	54	City.
Halifax	N. S.	lxxxiii.	Sept. 10.	364	36,102	1845		741,000.00				5,000,000	10,000.00	62,000.00	53.00	4,291	315		City.
Utica	N. Y.	cxx.	Oct. 22.	425	33,913	1849									30		190		Company.
Portland	Me.	cxviii.	Oct. 22.	425	33,810	1869		1,800,000.00		1,200,000.00	1880		10,000.00	100,000.00	37.2	4,616	242	43	Company.
Springfield	Mass	xliii.	July 30.	302	33,340	1860		1,216,847.58					16,008.31	79,380.32	63.68	3,260	381	44	City.
Wilkesbarre	Pa.	cxlvii.	Nov. 26.	481	23,339	1859		220,000.00	Wilkesbarre W. Co.	17,000.00	April, 1881			29,415.00	33	600	94		2 Companies.
Dubuque	Iowa.	cxl.	Nov. 19.	469	22,254	1871		140,000.00	Cap. stock, $300,000.		1880.					501	117	12	Company.
Holyoke	Mass.	xli.	July 30.	294	21,851	1873		312,142.29			1880.		28,892.52	39,362.52	24	3,689	441	59	City.
Norwich	Conn	xlvi.	July 30.	304	21,141	1868		411,870.94			March, 1880		6,262.92	24,169.24	30	1,503	245		City.
Salt Lake City	Utah.	clx.	Dec. 17.	509	20,768	1874		350,000.00		235,000.00	1880.	250,000	20,902.73	8,509.60	11		128		City.
Waterbury	Conn	lxvi.	Aug. 20.	332	20,629	1868		397,277.82		200,000.00	1880.		4,950.54	25,497.77	29	1,963	166	50	City.
Altoona	Pa.	lxix.	Aug. 27.	342	19,740	1871		300,000.00		300,000.00	1880.	500,000		12,000.00	16	1,400	98		City.
Williamsport	Pa.	xlvii.	July 30.	304	18,934	1863-65			Capital stock							2,500	150		2 companies.
Meriden	Conn	cxliii.	Nov. 26.	480	18,340	1869		350,000.00		325,000.00	1880.	1,000,000	5,739.39	32,561.74	24	1,700	190	51	City.
Newburg	N. Y.	lxviii.	Aug. 20.	332	18,050	1853		432,891.43		284,500.00	Mar. 7, 1881		4,863.89	27,334.50	20.5	1,789	181		City.
Johnstown	N. Y.	lxxx.	Aug. 27.	342	16,626	1878		59,806.11		60,500.00	Apr. 30, 1879.		728.79	2,800.00	4.6	109	53		City.
Racine	Wis.	cli.	Dec. 3.	489	16,031	70-78	Co. & City.	14,000.00			1880					200	4		Co. and City.
Leadville	Col.	clvi.	Dec. 10.	503	14,820	1879		300,000.00	Capital stock	65,000.00	1881	1,000,000	12,402.15	30,722.85	3	250	52	2	Company.
Pittsfield	Mass.	cxli.	Oct. 15.	413	13,387	1854		195,000.00			1876	1,500,000	1,800.00		30	1,800	70		City.
Northampton	Mass.	lxiv.	Aug. 13.	329	12,172	1870		209,322.84			1880		2,241.38	17,702.12	22		125		City.
Danbury	Conn	lxxxiv	Sept. 10.	364	11,669	1833	1860.	108,405.62			1880		1,320.00	11,193.97	15		105		City.
New London	Conn	lvi.	Aug. 6.	313	10,339	1872		291,840.00			Sept., 1880.		3,000.00	16,647.33	21	1,965		25	City.
Plymouth	Mass.	cxxxvi	Nov. 12.	459	7,094	1855		135,000.00		90,000.00	1880.	450,000	2,326.99	11,243.13	19.75	1,083	54		City.
Birmingham	Conn	xcvii.	Oct. 1.	393	7,000	1860		60,000.00			1880.		2,500.00		5	300	47		Company.
Keene	N. H.	cxxxii.	Nov. 5.	447	6,789	1869		162,689.58	1876.	150,000.00	Dec. 1, 1880.		1,132.94	8,487.76	20.5	825	121		City.
Mauch Chunk	Pa.	clxvii.	Dec. 24.	520	5,608	1849		95,000.00			1880.		750.00		4	430	28		Company.
Corning	N. Y.	lxix.	Aug. 20.	332	4,903	1870		40,000.00		250,000	1880.	250,000			7	200	45		Company.
Windsor	Conn	clxv.	Dec. 17.	510	4,500	1881		100,000.00		25,000.00	1881		2,666.47	4,704.94	10		85		Company.
Lambertville	N. J.	lx.	Aug. 13.	328	4,300	1878		20,000.00			Mar. 1, 1880.		2,908.86	4,759.19	3.72	50	28		Company.
Susquehanna	Pa.	cxxvi.	Oct. 29.	434	4,114	1874		6,000.00			1880.		55.00	600.00	0.75	5	5		Company.
Concord	Mass.	cxxvii.	Oct. 29.	434	3,295	1874		71,000.00			1880.		700.00		7.00	700	50		Town.
Hollidaysburg	Pa.	clxix	Dec. 24	520	3,139	1877		73,000.00			1880.		228.00		8.00	300	50		Town.
Bedford	Pa.	cl.	Oct. 1.	394	2,564	1872		34,000.00			1878.		275.00		8		45		Town.
Stockbridge	Mass.	cxxviii	Oct. 29.	434	2,361	1860		8,500.00			1880.	30,000	246.00		3				Town.
Great Barrington	Mass.	cxxv	Oct. 29.	434	2,341	1868		14,000.00			1880.			900.00	3.50	65	5		Company.
Avon	N. Y.	clxvi	Dec. 24	520	1,600	1857		18,000.00			1880.				8.00	225	21		Company.
South Hadley Falls	Mass	cxvii	Oct. 15.	414	1,500	1873		5,400.00			1876.	200,000	200.00		10.00	60	10		Company.
													500.00		6.00	230	42		Town.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 24.)

CLXXXI.—ALLEGAN.

Allegan, Michigan, in lat. 42° N., long. 87° W., on the Kalamazoo River, is in a valley surrounded by seven hills. The river has a rapid descent, affording a fine water power. Settled in 1833, it was incorporated as a village in 1837.

Water-works were built by the village in 1871 after the plans of Mr. Phelps, of Kalamazoo, taking the supply from two large wells sunk near the river which is dammed at this point by a dam of stone and earth 8 ft. high, which furnishes head to drive a turbine wheel which operates two Holly rotary pumps forcing water directly into the mains with an ordinary pressure of 80 lbs. and fire pressure of 120 lbs.

Distribution is by cast-iron pipe, of which 4 miles are laid of from 12-in. to 4-in. diameter, with 36 fire hydrants and 200 taps. Wrought-iron service pipe is used.

The population in 1880 was 3,010, and the daily consumption 25,000 gallons.

The works have cost $80,000 and the gross receipts have been about $110,000. There is a bonded debt of $17,500 bearing 10 per cent. The receipts in 1880 were $1,198 and the expenses $1,265.

The works are managed by a superintendent. This was held for three years by Alvy Rossman, and for seven years past by Clark Nichols.

CLXXXII.—SARNIA.

Sarnia, Canada, is on the St. Clair River, 2 miles below the foot of Lake Huron. Settled in 1830 it was incorporated as a town in 1857. Water-works were built by the town in 1876, under the direction of a committee of the council and R. Turner.

The supply is taken from the river through a 20-in. iron pipe 206 ft. long, and pumped directly into the mains by four Holly steam pumps arranged in pairs and working horizontally, each pair connected to one shaft. One pair has steam cylinders of 15-in. and water cylinders of 8¼-in. bore, with 18-in. stroke. The other pair has steam cylinders of 10¼-in. and water cylinders of 6-in. bore, with 15-in. stroke. The ordinary pressure is 33 to 35 lbs. and the fire pressure 80 to 110 lbs. Wood is used for fuel. Distribution is by cast-iron pipe of from 12 to 4-in. diameter, of which 9.20 miles are in use, with 74 fire hydrants, 131 gates and 528 taps. Lead service pipe is used.

The population in 1881 was 4,000 and the daily consumption 280,000.

The works have cost to Dec. 31, 1881, $59,590.60, and the receipts have been $17,699.75. The bonded debt is $70,000, bearing 6 per cent. interest. The interest is paid out of taxation. In 1881 the expenses were $2,635.74 and the receipts $4,184.44. The only accident which has occurred was the breaking of the suction pipe by ice a few years ago. This was repaired at a cost of $900. Robert Turner, the engineer and superintendent of the works, reports to a committee of the council.

[TO BE CONTINUED.]

The receipt of statistics as follows is acknowledged with thanks. From Stiles Kennedy, President, statistics and water rates of St. Louis (Michigan) Water-works. From Clark Nichols, Superintendent, statistics and water rates Allegan, (Michigan) Water-works. From A. A. Rankin, Water Commissioner and Superintendent, statistics and water rates of Greenfield (Mass.) Water-works. From C. R. Stickney, Clerk of Water Co., statistics of Chicopee (Mass.) Water-works and water rates. From Thomas C. Lovell, Superintendent, statistics of Fitchburg (Mass.) water-works and full set of reports of water commissioners from 1871 to 1880. From J. T. Sawyer, President, statistics and rates of water-works of Waverley (New York) Water Company. From D. A. McDonald, Manager, statistics and water rates of Batavia (N. Y.) water supply. From Robert Turner, Chief Engineer, statistics and water rates of Sarnia (Canada) water-works and reports for 1880 and 1881. From Charles W. S. Seymour, Superintendent, statistics and water rates of Hingham (Mass.) Water Company. From J. B. Quigley, Superintendent, statistics of Atchison (Kansas) Water-works. From James Middlemist, Superintendent, statistics of Delhi (N. Y.) Water-works Company. From J. O. McClure, Engineer, statistics and water rates of Warsaw (N. Y.) Water-works Company. From J. R. Todd, Registrar, municipal reports of Norfolk, Va., for year ending June 30, 1881.

In the tables which we publish to-day giving statistical information regarding the water-works of 175 towns, our readers will notice several blank spaces. The reason of this is that the information needed has not been furnished in reply to requests sent for it. We trust that some person in every one of the towns the statistics of which are imperfect, will, as soon as practicable, forward to Mr. Croes the missing data.

ENGINEERING NEWS.

GEO. H. FROST.....PROPRIETOR.

Tribune Building, New York City.

JULIUS W. ADAMS, *Past President A. S. C. E.*, EDITOR.

S. D. V. BURR.....ASSOCIATE EDITOR.

SATURDAY, JAN. 28, 1882.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe, $5, payablein advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

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Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

NOTICES OF MEETINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The regular meeting of the Society will be held on next Wednesday evening, at 8 o'clock, in the house of the Society, 127 East Twenty-third street.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The annual meeting will be held in Washington, Feb. 21, 1882.

PROF. A. J. Du Bois, Mem. A. S. C. E., Yale Scientific School, will lecture at Association Hall, Twenty-third street and Fourth avenue, this city, in the Lecture Course of the Young Men's Christian Association, on Friday evening, Feb. 3. Subject: "The Early History of the Steam Engine."

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EUROPEAN SYSTEMS OF SEWERAGE.

In 1880 Mr. Rudolph Hering, Civil Engineer, of Philadelphia, visited Europe for the purpose of examining the various systems of sewering cities as practiced there and the applicability of the various methods in use, wholly or in part, to this country, and in a report made to the National Board of Health gives at length the result of his observations with a thoroughness which leaves nothing to be desired. The National Board of Health published this report in a supplement to their Bulletin of Dec. 24, 1880. Mr. Hering spent many months in the examination, and the report is the result of much patient labor and close observation, and shows an intelligent grasp of the salient points of this intricate problem as exemplified in the practice of the oldest countries, and illustrates the principles deduced therefrom so happily that, in the interest of sanitation in this country, we are induced to call attention to this report as embodying *principles* which are applicable to all localities. In the cities of London, Paris, Berlin, Vienna, Liverpool, Hamburg, Frankfort-on-the-Main, Dantzic, Brighton, Oxford and Amsterdam Mr. Hering furnishes copious notes under the various headings of statistics of the locality, population, area, number of dwellings, mortality, etc., management of the works, design and construction, shape, size, depth, grade, ventilation, etc., of the sewers, materials of construction, disposal of sewage, cost of construction, as also of management and maintenance and details of all important appliances in vogue in these various cities, from the operations of which, as observed by him, he deduces the principles enunciated in his report. The drawings accompanying this report, we learn, are marvels of accuracy and clearness, and which will be published by the National Board of Health, in their Bulletin for 1881.

The reports of the various cities are very minute, and do not admit of epitomizing, but will form the subject of future papers in ENGINEERING NEWS, as being of great value to our readers.

In the introduction, the author considers the various causes which tend to influence the judgment in forming an opinion as to the merits of particular systems to be accepted, and shows that the question should really resolve itself into considering it in *two* aspects: First, as the works are to receive, convey and discharge organic waste products, the decomposition of which is either directly or indirectly the cause of unhealthy influence, it is necessary to examine them, first of all, from a *sanitary* point of view. When a satisfactory standard in this direction can be reached, the next inquiry is into the expense attached to their execution; in other words, into the least possible *cost* at which a sanitary condition can be attained. These two considerations alone decide their merits. It will be found that several of the systems, if properly designed, constructed and maintained, will have no serious sanitary defects, and that their relative advantages will depend mainly on the question of *cost*. As the latter varies with the local conditions, it is evident that these will almost wholly determine the selection of the system.

GENERAL SYSTEMS AND THEIR APPLICATIONS.

These systems are two, the "dry removal" and the "water carriage." After explaining the principles of each, and considering the circumstances under which "cesspools" are least harmful, and are to a certain extent admissible in certain localities, the author proceeds to explain the various methods in use for "dry removal," and concludes that it can compare favorably with the "water-carriage" system only under the following circumstances:

1. Small towns, on account of the expense of cartage.

2. Towns where the regular exchange of the pails used can be enforced with almost military exactness, as in barracks.

3. Dwellings where water closets cannot be used.

4. Localities where works of sewerage would be very expensive; and

5. Where the waste water can be led over the surface of the ground without causing offense.

It will depend, therefore, entirely on local requirements and peculiarities, to determine which of the two methods is more desirable.

The system by "water carriage" (what is called "sewerage") is then examined, which consists in a system of continuous undergrou nd impermeable channels causing an immediate and complete self-removal of all excreta and waste water from the dwelling to the place of final deposit or disposal.

The history of the subject then comes up, and the circumstances under which the demand for improvement in sewerage works arose, and the origin of the "separate" system of water carriage, and the reason for regarding some one of the water-carriage systems as preferable to the dry methods, and the circumstances under which it is to be preferred, as

1. When a regular water-supply in sufficient quantities is furnished to the dwellings, this being the most essential condition.

2. When waste water is sufficiently abundant and foul, and therefore requires rapid removal to a distant point, which will usually follow the present condition, especially in large towns.

3. When the population is dense, which relatively decreases the expense per inhabitant.

4. When the topographical features and locations of the town do not require an unreasonable outlay of money. Water carriage, for instance, would not be economical to small towns on very steep and irregular slopes, with the rock near the surface, or where the site is a long, narrow strip along the shore of a large river, when the expense of sewerage would be out of proportion to its benefits over the dry-removal method.

5. Where the disposal of sewage offers no great difficulties or expense.

6. Finally, in general, where the interest of the amount invested in sewerage bonds will be smaller than the cost of dry removal, provided the latter is kept up to a sanitary standard. This condition will cause the advantages of water carriage to increase with the size or the cities, but the precise point at which sewerage becomes cheaper than the dry removal can only be determined from the local peculiarities.

After considering the relative merits of the dry method, and that of the general water carriage, we come to consider the latter more in detail, when it divides itself into the "combined" and "separate" system; the latter again sub-divided into the ordinary, the Shone, and the pneumatic, or Lierneur-systems.

The *combined* system consists in a network of sewers, having sufficient capacity for the removal of a certain amount of storm water, in addition to the sewage, and having inlets for its reception along the streets as well as in the yards and houses.

The necessary arrangements with reference to street-basins, traps, ventilation and inspection are than stated, and the combined system, which is the one generally in use with us, is carefully considered in all its bearings, and, after giving the advantages of the method, the objections which are urged against it by the advocates of the separate system are fairly given, so that one should be in no doubt as to their relative merits. The objections against the combined system, on sanitary grounds, are considered as substantiated only when it has been imperfectly designed, built, maintained or applied—difficulties to which the separate system is equally exposed, and perhaps from its greater complexity in some cases even in a greater degree. Where purification of sewage is needed it will depend upon local conditions whether the combined system, with proper interception of sewage, is to be therefore avoided, but our author is positive that it "will not be on any general defect of the system itself."

The expense of a sewerage system does not merely include its first cost, but its annual cost as well, for maintenance. When systems are compared financially, it should be done with reference to the objects they accomplish. The combined can naturally only compete with the separate system"' in cases where both sewage and rain-water alike are to be provided for." The economy of the combined or separate system depends mainly on the following conditions:

Where rain-water must be carried off underground from extensive districts, and where new sewers must be built for this purpose, it will generally be cheaper; also in densely inhabited districts, from the circumstance that the proportion of sewage to rain-water will be greater, and therefore increase the sizes of the separate-sewage pipes, yet without decreasing those of the rain-water sewers; while the sizes of the combined would not vary with the population because the quantity of sewage is much less than the quantity within which the amount of storm water can be estimated; but what is of more importance is the fact, that in closely built up sections the surface washings from slight rains would carry an amount of decomposable matters into the rain-water sewers, which, when it lodges as the flow ceases, will cause a much greater storage of filth than in well-designed combined sewers which have a continuous flow, and generally also appliances for flushing. In cities which give indications of rapid growth these points become of importance when selecting a system.

Separate System.—The ordinary separate system as used in England consists of a pipe line extending into each house, there to receive the house drainage, generally with some rain-water from the yards and back buildings. The remainder of the rain-water is taken off through separate sewers, or over the surface. Flushing arrangements of some kind are necessary, as are also man-holes for inspection. Where the Field tank is used, no necessity exists for taking any rain water into the house drains. But experience is still needed to determine how for it becomes proper to exclude all rain-water. Good examples of this system are found at Oxford, Reading, Tottenham and some other small English towns.

The Shone System.—This is a variation of the ordinary separate system, and consists in lifting small quantities of sewage at any convenient number of points, so that it can continue its course in shallower sewers, and with better grade. The economy and convenience of compressed air in transmitting power to long distances in comparison with steam direct makes the principle a practical one, but this method has been put in operation as yet but on a small scale for experiment in one locality in Wrexham, but the principle would appear to be sufficiently applicable to peculiar localities as to justify its consideration as a system, the value of which remains to be proved.

The Lierneur or pneumatic system is then explained, and the relative merits of these separate systems, as compared with the combined, are fully gone into; and as the sanitary demands upon a system of sewerage consist in the prevention of decomposition to the greatest possible extent, this object can best be obtained by a rapid, steady and complete removal of all decomposable matter entering the sewers in a fluid state, and also such solids as occasionally enter them and obstruct the flow, and a provision for the safe escape of vitiated air. These demands can be fulfilled within satisfactory limits by each of the system named, provided they are designed and built in a perfect manner, and in accordance with the peculiarities of the locality and proper care given to the maintenance. A misapplication on one hand, a neglect on the other, may have a greater influence on the sanitary condition growing out of any single system than the difference between any two systems can have under good conditions; and as the conditions are so liable to variation in different localities no one particular system can possibly be the best for all localities.

Mr. Hering, after a careful review of all that has been accomplished and a proper consideration of what has been promised, reaches the following

conclusions as to the requirements of the several systems.

"The combined system is suitable when rain-water must be carried off underground from extensive districts, especially when they are closely built up, as in large cities, and where new sewers must be built for this purpose.

"Where purification is not required or is not difficult, and storm-water overflows are not objectionable in polluting the streams.

"Where a sufficient amount of water or sewage is available for flushing the larger sewers.

"The best examples were found in Frankfort, London, Hamburg, Brighton, Liverpool, Berlin and other towns.

"The separate system is suitable where rain-water does not require extensive underground removal and can be concentrated in a few channels slightly below the surface, or where it can safely be made to flow off entirely on the surface.

"Such conditions are found in rural districts, where the population is scattered, on small or at least short drainage areas and on steep slopes or side-hills.

"Where there is an existing system of old sewers, which cannot be made available for the proper conveyance of sewage, yet can be used for storm-water removal.

"Where purification is expensive, and where the river or creek is so small that even diluted sewage from storm-water overflows would become objectionable, especially when the water is to be used for domestic purposes at no great distance below the town.

"Where pumping of the sewage is found too expensive to admit of increased quantity from intercepting sewers during rains, which can occur in very low and flat districts.

"Where it is necessary to build a system of sewers for house drainage with the least cost and delay, and the underground rain-water removal, if at all necessary, can be postponed.

"Under such conditions the ordinary separate system can generally be applicable, yet certain special features of the locality may determine in favor of Shone's system; for instance:

"Where pumping of the sewage to moderate elevations is advantageous or required at several or numerous points not greatly distant from each other, in order to increase the grade and velocity between them.

"Where deep excavation is very expensive, either from being under the level of subsoil water or in rock, and where shallower sewers with better grades and intermediate lifts could be substituted, as in undulating grounds with rock near the surface when the sewage is to be carried across the ridges, or in low-lying and very flat districts with excavations under water.

"Finally, in mentioning the applicability of Lierneur's system, it must be added that it is extremely doubtful whether it can compete with the other systems in any locality.

"In conclusion it may be said that as quite different conditions may occur in the same town, it is possible and practicable to adopt several systems for it. It may be found expedient to exclude rain-water from certain areas, whereas the combined system would be advisable in others."

ON THE DESIGN AND CONSTRUCTION OF SEWERS.

The *alignment* is first considered, and its bearing on the efficiency of the works shown, but the reference to plates (which are as yet unpublished), as essential to a proper understanding of the subject, will prevent our following the author in this branch of the subject.

The next consideration is that of size, shape, grades and construction.

Size.—This, as aside from other considerations affecting very seriously the cost, is a matter of the first importance. If too large, it is liable to become obstructed by deposits, and if too small, to choke, or fail to carry off the sewage.

Experience has led engineers to be careful in both directions. The smallest sizes for common sewers used in Europe are 8 or 9 inches. Up to a diameter of 18 or 20 inches, vitrified pipe are used, beyond this concrete or brick. Where sewage alone is to be conveyed, its quantity determines the size. This quantity is usually taken as equal to the water supply, but unlike the latter, about one half is estimated as discharged in from six to nine hours, and should fill the sewer to about one half of its capacity. Where rain-water is to be carried off the quantity estimated is very variable; this variation and the causes are explained, and attention called to the variation which appears between the amount of rainfall in a given time, and the amount which reaches the sewers, and the necessity which exists for more extended observations on this point. In this connection, as it is well known that over extended areas the amount to be delivered is not in the direct ratio of the areas to be drained, Mr. Hering submits a formula (the result of extended observations in Germany) for the determination of this quantity and wherein the amount given by the formula increases as the rate of rainfall increases, as the slope increases and as the surface is less premeable to the water, and *decreases* proportionately as the area increases. The only formula heretofore in use which has a similar tendency is the one recommended by the editor many years since, and used by some engineers, known as Hawksley's, which was used in the main drainage works of London for the outfall of storm waters. I s this, A = acres drained with a rainfall of 1 in. to the hour,* N = length in feet in which the sewer falls 1 ft.

$$\frac{3\ log.\ A + log.\ N + 6.8}{10} = \text{log. diam. of outfall in inches.}$$

The formula recommended by Mr. Hering is:

$$Q = c\,t\sqrt[4]{\frac{S}{A}}$$

wherein Q = cubic feet per acre per second reaching the sewer.

c = coefficient ranging from 0.31 to 0.75, depending upon the nature of the surface, the higher coefficient being for paved streets and roofs, the lower for rural sections in suburbs.

t = average intensity of rain during the period of the heaviest fall, in cubic feet per second per acre, the amounts ascertained for Central Europe being found to be at the rate of from 1¾ to 2¾ per hour.

S = general grade of area drained per thousand.

A = area drained in acres.

Eytelwein's formula is generally used in London, Berlin, Hamburgh and Liverpool; Prony's in Paris; Darcy and Barquis' in Vienna, Lindley's in Frankfort. The results differ but little when the formula is properly applied.

Shape.—The shape of sewers is not uniform in practice. Generally the egg shape is adopted for all sewers of the combined system, when large enough to be entered; when smaller, the circular shape is preferred. In Paris, owing to the method of cleansing by flushing trucks, a composite section becomes necessary, the edges of a *cuvette* in which the sewage flows being provided with iron rails for the wheels of the trucks. On one or both sides is a foot-path for the workmen, and the whole covered by a semicircular arch, within which water pipes and telegraph wires are suspended. Branch sewers in Paris are oval.

The egg-shaped sewers in Paris, Vienna and Hamburgh have a comparatively flat invert, others more pointed ones, as in England, in Frankfort and Berlin. The latter appear the more preferable form, as they were found to need less cleaning and flushing than those with flat inverts. In Frankfort, where on account of the narrow streets many of the sewers were built by tunneling, it was preferred to build brick sewers 3 ft. high where, indeed, a pipe sewer would have sufficed.

Gradients.—The grades determined measurally by that of the streets, are made, as a rule, as great as practicable. In England it is not recommended to give a velocity greater than 6 ft. per second, to avoid wearing away the inverts. In Berlin, the velocity is reduced to that which will prevent deposit. House connections require a grade seldom less than 1 in 50, Valley line sewers rarely less than 1 in 1,000, and intercepting sewers were given grades as low as 1 in 4,200, as in Paris. In Hamburgh and Westham, near London, some were built even level, and during floods discharged in either direction. In the discharge of storm water, the hydraulic grade is to be considered, and not that of the invert; this is particularly necessary to be regarded in sewers discharging at tide water, the hydraulic grade having its reference to high tide. It will be noted, that to give the same velocity as large sewers, the grade of small sewers must be greater than the large.

Construction.—One of the reasons why the European sewerage works, whenever they had any pretensions of being built on a system, are better than ours, is mainly owing to the greater care which is generally given to their construction. The materials are more carefully selected, and the works are more substantial. Sub-soil drainage is affected in some places, as Oxford and Berlin, by a line of drain-pipes laid below the sewer. In Vienna and Breslau they are laid over or on each side.

The relative smoothness of the sewers is found to have an appreciable influence in preventing deposits. Pipes, except near dwellings, when grease adheres to the sides, show but a slight coating of adhering matter, as compared with sewers of brick and stone. Concrete, when smoothly plastered with cement, likewise showed but a slight coating, if any. The odors from concrete sewers so plastered were said to be less than from brick sewers, and inspection confirmed it. In Vienna one of the water reservoirs was partly lined with a smooth coating of cement, and partly faced with sandstone. The clean condition of the former, compared with the slimy, greenish surface of the latter, although built at the same time, would seem to confirm this opinion.

Junctions.—Attention is called to the proper method of connecting branches, as of more importance than generally supposed. House drains and small pipes are usually made from 30° to 45°; on large sewers, with as long radius as is practicable, but in smaller sewers other considerations may limit the length of curve to the length of a man-hole, that one man-hole may command a view for inspection over two tangents. In large sewers, to prevent eddies (a fruitful cause of deposits), great care is necessary to make the junction as gradual as possible, and at the same time the channel district. This is effected by the so-called "tongues," built at the intersections, which cannot be well explained without the drawing. Eddies, and therefore deposits, were entirely avoided by this device, as was apparent wherever they were used in England, Frankfort and Hamburgh, and the reverse apparent where they were not used in Berlin and Paris.

Appendages, such as street basins, man-holes, outfalls and overflows are next considered. Great diversity of practice obtains as to the size of the street basins. Their depth is dependent upon the climate, being twice as deep in Germany as in England, and with reference to the vicinity for tapping the outlet to the sewer, in some localities it appears to have proved beneficial to dispense with any taps for the street basin, but Mr. Hering is not prepared to recommend it for American cities. The use of man-holes varies both in dimensions and frequency. Over small sewers, they should be at less intervals than in large sewers, and should be placed at every change of direction and grade. In Paris they are fixed at 164 ft. apart; in Vienna the distance is about 200 ft.; in Hamburg 350 to 400 ft.; in Frankfort 540 to 600 ft. for large and 250 to 300 ft. for small sewers, and have open grating covers for ventilation, and catch-pans beneath to arrest the street detritus.

Storm Overflows.—These are mostly confined to intercepting sewers, and their uses are sufficiently apparent, but require to be properly adjusted to the service expected of them.

Outfalls.—The positions of these are mainly determined by the topography of the locality. When the hydraulic gradient cannot be raised to high water at the outfall without causing the flooding of cellars or even entire districts in the city, it becomes necessary to close the outlet by a penstock or tidal flap to prevent the tide-water from entering the sewer, which then acts as a storage tank until the tide recedes. This treatment is common in London, Hamburg, Dantzig and other places. In the case of a heavy rain-storm during the time when the sewers are locked against high tides, serious results are apt to follow if some such provision be not made.

Ventilation.—On this subject there are very decided and opposing views. Many different methods have been tried and none of them singly have satisfied all requirements. Mr. Hering explains the various methods with the objections to each, and describes the most common and effectual and least expensive method to be the man-hole shaft with iron grating and provided with pan, as mentioned under the head of man-holes, and he classes this branch of the subject as follows: "The conclusions which present themselves may now be stated as follows: The most economical and effective method of ventilation is by short shafts in the streets, placed at frequent intervals. The next best method is a free communication with the outer air through the soil-pipes of houses under the proviso that they are properly constructed."

Under the head of *maintenance of sewerage work* the following remark is worthy of consideration: "A striking contrast is observable between the average ordinary condition of the sewers in European cities and in America, and it is in this want of proper maintenance perhaps more than in any other point that our sewerage works have often failed to answer their intended purpose. If sewage were a uniform substance like water-gas or air, its conveyance through channels could be as readily accomplished as the water and gas supply of a city. But the sewer contains fluids, solids and gases of the greatest variety in bulk and weight, and sometimes in proportions which cause injurious conditions, or imperil the proper action of the sewers. Entire self-acting, therefore, cannot be relied upon. Occasional inspection is unavoidable in order to prevent serious obstruction, and artificial assistance in removing deposits becomes necessary from time to time." And this brings us to the methods in vogue for cleaning sewers.

Free Flushing by means of Sewage or Water from the City Supply.—Some cities, such as London, Berlin, Dantzig and Oxford, apply the city water by hose led into the man-holes; in others the sewage is dammed by flushing slides; in brick sewers flushing gates and penstocks are permanently built into the works for such use.

The intervals between these gates depends upon the grades and sizes of the sewers. It varies greatly, ranging from 300 to 5,000 ft., and the

* When calculating the rainfall reaching the sewers to be ¼ in. in 24 hours, plus the sewage, the practice in England has been to use Eytelwein's formula of the form:

$$\text{Vel. in feet per sec.} = \frac{9}{10}\sqrt{\text{mean hydr. depth} \times \text{twice the fall in feet per mile.}}$$

frequency of the flushing depends upon local peculiarities, as in Berlin, every two weeks, and in England at intervals of from one to three months. Flushing by means of movable dams, as used in Paris, is more expensive than by gates, but when none of these methods will remove the obstructions, the cleaning by hand tools is resorted to, such as scrapers, brushes and other means of loosening the silt are drawn through the sewers, which may then yield to the operation of a flush by damming the sewage. When neither of these methods will answer, jointed hooks are sometimes inserted, which close when pushed into the pipe, but opens by a spring when pulled back and acts as a hoe. Whatever the means employed, it is done at regular intervals and in a systematic manner.

Cost of Construction.—This is tabulated for the cities examined, showing the cost per foot, as also the cost per inhabitant. By the latter method, in London, Berlin and Hamburg the cost varies from $11.25 to $16 per inhabitant. In Dantzig, the cost has been but $6.25, while in Liverpool it is as high as $19 per inhabitant. These differences, however, admit of explanation, and bring the cost per foot of sewer nearer to an equality in the various cities.

Cost of Maintenance.—In this Paris gives the highest figure, viz., 13 cents per foot; Vienna 9.3 cents. London averages 6 cents; Berlin 4.3 cents, and Hamburg 3.6 cents per foot; Frankfort 3.5 cents; Liverpool 3 cents. When the cost of maintenance is computed per inhabitant it shows in London at the rate of about 17 cents per head; Liverpool 14.7 cents; Berlin 10.1 cents; Hamburg 6.6 cents; Frankfort about 10 cents; Paris 13.5 cents, and in addition about 55 cents per head for removing the night soil. In Vienna, cleaning sewers, 7 cents per head, and removing night soil, 10.5 cents per head in addition. The last two cities show the great expense of dry removal over the water carriage.

Disposal of Sewage.—While our author touches upon this much-disputed branch of the subject with sufficient caution, yet his observations lead him to the following opinion: "The expectation entertained for a long time that town sewage could be converted into a valuable manure, which would not only pay for the conversion but render it profitable besides, has been given up, *save by a few parties interested in patent processes.* The general opinion held at present is that sewage must, beyond all other considerations, be disposed of in a way which is least injurious to the community; that a pecuniary profit cannot be looked for in every case, and that essential differences in topographical, physical, and geological conditions will require essentially different modes of treatment;" and, as we might suppose would be the case, as the cost of land near a city generally increases in proportion to the size of the city, the cost of purification by the method of irrigation or filtration (sewage farms) per head of population, will, *cæteris paribus*, be more expensive for large than for small towns.

THE BENEFITS OF ENGINEERING SOCIETIES.

In commenting upon the last annual report of the Institution of Civil Engineers, a contemporary remarks that the perusal of said report—

"Cannot fail to awaken feelings of satisfaction and pride among the members of the Institution to which they belong. The association is a powerful one, numerically and financially, and its usefulness to the profession cannot well be overrated. The advantages to be derived from the Institution building itself are, of course, limited to those who are able to make personal use of them, but the Transactions, which grow in size and value from year to year, are delivered at short intervals to members in all parts of the world, and who are thus more favored than the members of any other existing association. Foreign members, too, if they are debarred from attendance at the weekly meetings, and from the use of the reading-room and magnificent library, have full amends made to them by the improved status which their connection with the Institution bestows on them. If membership at home is a convenience, abroad it is a privilege; neither definition probably expresses exactly the benefits attached to the connection, though it defines accurately its relative advantages."

The above remarks apply to membership in the American Society of Civil Engineers, which is rapidly coming to be a measure of professional standing and which, with its increasing members, its valuable library and museum, and its contributions to engineering literature through its published transactions, must inevitably exert a very great influence upon the country at large through the planning and superintendence by its members of the great public works that are to be built during the coming years. This is certainly an era of awakening among engineers and surveyors, who, in numerous associations, are combining to secure the advantages of mutual aid in the discussion of professional papers and in the unity of effort for political recognition and consideration. The amount of valuable information already gained through the medium of local engineers' and surveyors' associations cannot be estimated, and with the impetus now gained the labors of these societies must eventually result in great good to the profession and to its patrons, the public. We feel, therefore, that engineers should be encouraged to unite with some association and especially aid in building up one strong, well-endowed central society, which will be for America what the Institution of Civil Engineers is to Europe.

PERSONAL.

CAPT. T. S. ANDERSON, who has been Chief Engineer of the levees in Mississippi for the last six years, has been forced by impaired health to retire from his duties as such, and has moved to San Antonio, Tex. The Board of Mississippi Levee Commissioners at a recent meeting passed the following order and resolution: "It is ordered that the report of Chief Engineer T. S. Anderson be received and filed among the records of the Levee Board and be it resolved that in severing the relations which have so long and pleasantly subsisted with this engineer, the board bears most willing testimony to his thorough efficiency, combined with the highest order of personal character. Exemptions from ruinous overflows for a long period and a greatly improved system of levees attest his merit, and the painful necessity which severs his connection with the Board is regarded by us with sincere regret and deepest sympathy."

GORHAM P. LOW, C.E., recently on the N. Y. & N. E. R. R., has been appointed Superintendent Road Department of Elizabeth City & Norfolk Railroad, with headquarters at Norfolk, Va.

GEO. B. FRANCIS, C. E., late an assistant in the City Engineer's office, Providence, R. I., has been appointed Assistant Engineer N. Y., W. S. & B. R. Ry., with headquarters at Poughkeepsie, N. Y.

PENSACOLA & ATLANTIC.—The engineer corps of this road is made up as follows: Chief Engineer, A. W. Gloster; division engineers, George B. Pickett, Colin A. Davis; resident engineers in charge of sections, John M. Cook, W. K. Atkinson, Frank Matthews, E. F. Jones, J. B. Billups, Paul Montfort, J. B. Clifton, O. H. Crittenden, A. M. Glassel; Assistant Engineer in charge of piling and bridges, Nesbit Winfield.

H. A. SUMNER has been appointed Chief Engineer of the St. Louis, Keokuk & Northwestern and Chicago, Burlington & Kansas City railroads, with headquarters at Keokuk, Iowa. All business relating to track, bridges, buildings and water stations will be transacted through him. By order of Jno. W. Smith, General Superintendent.

MR. RICHARD P. MORGAN died at Dwight, Ill., Jan. 21, aged 92 years. He was probably the oldest civil engineer in the country, and had been employed in the survey and location of many important roads, including the location of the Western (now Boston & Albany) Railroad in Massachusetts. He retained his interest in his profession to the last, although his great age had deterred him from active work for several years past. He leaves two sons, Col. Richard Morgan, of Bloomington, one of the first board of Railroad Commissioners of Illinois, and Mr. George Morgan, of Chicago, who are well-known engineers.

THE HON. CLARKSON N. POTTER, famous as a politician, statesman and Democratic leader, died in this city on the 23d inst. He was sick but a few days, although his health had not been robust for several years. His life has been passed largely in politics and public affairs. His greatest prominence was attained in 1876, as a member of Congress and a member of the Electoral Commission, and afterwards as chairman of the committee to investigate the cipher dispatches. He was born in Schenectady, N. Y., in 1825; graduated at Union College, of which his grandfather, Rev. Eliphalet Nott, was president, and his father, Bishop Alonzo Potter, was vice-president, in 1842; graduated at the Rensselaer Polytechnic Institute as a civil engineer in 1843, and was a surveyor in Wisconsin; studied law in that State, and after coming to the bar commenced the practice of his profession in New York City in 1847; held no public offices, but was engaged in many important cases; was elected to the Forty-first Congress, and was re-elected to the Forty-second Congress as a Democrat, and again in 1876, as we have stated. He was a high-minded, courtly man, and of the best type of political leaders.

CHARLES STROUD, of Canastota, died of heart disease at Syracuse on the 20th, aged 82. He was a large contractor when the Erie Canal was enlarged.

C. E. SPRAGUE, C. E., late of the B. & A. R. R., Springfield, Mass., has been appointed Assistant Superintendent of Bridges and Buildings on the C. M. & St. P. R. R., with headquarters at Minneapolis, Minn.

PROF. GEO. L. VOSE, C. E., of the Institute of Technology, Boston, on Thursday evening delivered a lecture before the Society of Arts in that city upon the "Inspection of Public Works," with special reference to the present method of building and inspecting railroad and highway bridges in the United States.

ALEX. WADSWORTH LONGFELLOW, of Portland, Me., obtained the highest honors of the seven American architects graduated this year at the Ecole des Beaux Arts at Paris.

ATLANTIC & PACIFIC RAILROAD COMPANY (WESTERN DIVISION).—The following circular has been issued by Acting Engineer Kingman, under date of Jan. 2, 1882: "R. N. Billings is hereby appointed Resident Engineer, with head-quarters at Cranes, N. M., to take charge of track, bridges and buildings, from Albuquerque to the Front; to lay out, measure and estimate all contract work, and superintend the same, that may be necessary for the improvement and protection of the road-bed. The Master Carpenter, road masters, construction trains and water service will be under his direction and subject to his orders. Their check rolls and accounts must be sent or handed to him; and no accounts from his jurisdiction will pass this office without his approval. He will be expected to look after the work and see that men intrusted to responsible positions do their work faithfully, and hold those under them to their duty. W. A. Drake is hereby appointed Resident Engineer, with head-quarters at Williams, Arizona, to take charge of construction from section 306, at Padre Cañon, to section 554, at the Colorado River. The several division engineers (except T. F. Richardson) will be subject to his orders. He will be required to certify to all vouchers, estimates, check rolls and accounts of the division engineers in his charge; to examine their work and notes, and to see that they are correct before being sent to this office; to see that division engineers give grades and centers, and attend to their other duties faithfully. The following division engineers, who have heretofore been employed by Mr. Holbrook, are continued in their several places: T. F. Richardson, to have charge of the masonry and grading from and including Cañon Diablo to and including Padre Cañon. All matters pertaining to that work will be under his charge, and he will report direct to this office. C. F. Lawton, in charge of division from section 306 to 325 inclusive; John McGuire, in charge of division from section 326 to 351 inclusive; Geo. S. Van Law, in charge of division from section 352 to 374 inclusive; Horace Ropes, in charge of division from section 375 to 384 inclusive; J. M. Clark, in charge of division from section 385 to 4 0 inclusive; F. W. Meeds, in charge of division from section 411 to 436 inclusive; C. S. Henning, in charge of division from section 437 to 460 inclusive; H. C. Todd, in charge of division from section 461 to 476 inclusive; Albert Drake, in charge of division from section 476 to 492 inclusive; W. G. Middleton, in charge of division from section 493 to 510 inclusive. All division engineers (except T. F. Richardson) are required to report to W. A. Drake, Resident Engineer. All orders from this office will be transmitted through him, except in cases of emergency, when they will be sent direct. All division engineers are requested to send a weekly report to this office, giving information in regard to the progress of the work, number of men employed and points of interest. Write short, comprehensive letters, pointing out any defects, so that the Chief Engineer can act intelligently in regard to the work. H. B. Hedges, William S. Steel and R. R. Swisher are now appointed Division Engineer's assistants, to remain in their several places until further notice. Alfred Gregory, who has heretofore been in charge of the bridging at the Front, will remain in charge and complete the repairs of bridges heretofore contemplated, and report at this office. William F. Hill, who has been acting as assistant to R. N. Billings, will report to him until further notice. A. W. Phelps, who has been in charge of the Material Yard at Cranes, N. M., will continue in that place; make weekly reports as heretofore, and send one copy of the same to F. W. Smith, General Superintendent, and one copy of the aforesaid report to this office. Ralph Halloran, who has heretofore occupied the position of Commissary, will continue to act in that capacity. All accounts, vouchers and contracts with freighters, a weekly statement of about what is on hand, together with an occasional letter in regard to the business, are to be sent to this office. J. C. Miner will continue to inspect ties and timber, and report to this office. Walter C. Sanders, who has heretofore acted as Chief Clerk, will continue in that capacity. C. W. Sanders, who has heretofore acted as Office Engineer, will continue as such. Wm. McAdams, A. C. Aldrich, F. W. H. Cutter and C. J. Quitel, who have been draughtsmen in the office, will continue in their several places. Resident Engineer R. N. Billings is authorized to issue passes at his discretion to the employés of his department."

OBITUARY.

We regret to announce the death at Milwaukee, on the 25th inst., of MOSES LANE, for many years City Engineer of that city. Mr. Lane was born in Northfield, Vt., in 1824, and graduated at the Vermont University. He adopted the profession of a teacher, and for several years was engaged as principal in various seminaries of learning. Subsequently adopting the profession of civil engineering, after a brief service in railroad surveys and construction in Vermont and New Hampshire under I. C. Chesbrough, C. E., he was appointed principal assistant to Mr. Kirkwood, from the commencement of the construction of the Brooklyn Water-works in the summer of 1856 to their completion, and was appointed Chief Engineer in 1863, which position he held until May, 1869, when the inauguration of important public works at the West opening a wider field for usefulness, he removed to Milwaukee, the extensive water-works of which city he designed and executed, and, with the exception of short intervals, continued as its city engineer until the time of his death. Aside from the construction of this and other works in the Northwest, he was largely employed as consulting engineer on important undertakings connected with city drainage and water-supply throughout the country from New Orleans, La., to Boston, Mass.

Mr. LANE was noted for extreme simplicity of manners and modesty of deportment, and averse to making himself the central figure in any company, frequently doing injustice to himself rather than in the slightest degree to encroach upon the claims of others. To a casual acquaintance, this might appear as a defect almost amounting to weakness; but to those who knew him, nothing could be further from the fact than such an estimate of his character, possessing, as he did, in no common degree, the true elements of a noble manhood, a thorough contempt for shams and falsehood, and fearing nothing for himself when in the way of truth and duty. In this respect it could be said of him that he possessed amiability without weakness, and strength without aggressiveness.

A member of the American Society of Civil Engineers, and Vice-President of the Society of Engineers of the Northwest, his professional reputation constitutes a part of their record, and his various labors in his profession will receive from them due notice; but his qualities as an engineer, high as they were acknowledged to be, were by no means the most striking points of his character, and it is to be hoped that whoever may be assigned the task of making out his professional record may have enjoyed the pleasure of social intercourse with him, that they can, to a limited extent at least, do justice to his many sterling qualities. *Requiescat!*

ENGINEERS' SOCIETIES.

ANNUAL MEETING OF THE A. S. C. E.

The following is a corrected list of the names of those who attended the meeting on Wednesday, Jan. 18: Lyman Bridges, Chief Engineer California Central Railway; Theodore N. Ely, Pennsylvania Railroad; Octave Chanute, Chief Engineer Erie Railroad; Sanford Fleming, ex-Chief Engineer Intercolonial & Canada Pacific Railroad, of Ottawa, Can.; Chancellor of the Queen's University, Kingston, Can.; David Reeves, Phœnix Iron Company, Philadelphia, Pa.; Heny G. Morse, of the Morse Bridge Company, Youngstown, O.; Joseph M. Wilson, Engineer of bridges and buildings of the Pennsylvania Railroad; Joseph Waltz, City Engineer of Dayton, O.; Charles Kellogg, of the Kellogg & Maurice Bridge Works, Athens, Pa.; F. C. Prindle, United States Navy; William H. Bradley Superintendent of Sewer Construction, Boston, Mass.; Martin Coryell, Lambertville, N. J.; Charles G. Darrach, First Assistant Engineer of the Philadelphia Water-works; Gen. Theodore G. Ellis, Engineer on the Government improvements on the Connecticut River, Hartford, Conn.; William P. Shinn, New York City; William H. Searles, Engineer of the West Shore Road, Newburg, N. Y.; Marshall M. Tidd, Boston, Mass.; Charles E. Fowler, City Engineer, New Haven, Conn., and Albert B. Hill, his first assistant; Gen. William Sooy Smith, Chief Engineer of the Hudson River Tunnel; Capt. Otto E. Michaelis, Ordnance Corps, United States Army; William Metcalf, Crescent Steel Works, Pittsburgh, Penna; Erasmus D. Leavitt, Jr., Chief Engineer Calumet & Hecla mine, Lake Superior, Mechanical Engineer of Lynn & Lawrence (Mass.) Water-works and constructor of the sewerage pumping-engines of Boston, Cambridgeport, Mass.; Samuel M. Gray, City Engineer, Providence, R. I.; David M. Greene, Director of the Rensselaer Polytechnic Institute, Troy, N. Y.; Clark Fisher, Trenton, N. J.; Theodore Cooper, New York; L. L. Buck, Central Railroad of New Jersey, New York; Col. W. H. Paine, Francis Collingwood, C. C. Martin and G. W. McNulty, Engineers East River Bridge; Geo. W. Dresser, *American Gas Light Journal*, New York; John Bogart, Secretary of the Society; J. J. R. Croes, Treasurer of the Society; Alfred P. Boller, Chief Engineer Albany & Greenbush Bridge; George H. Frost, ENGINEERING NEWS; Thomas C. Clarke, Phœnixville Bridge Works; George S. Morison, Chief Engineer Bismarck Bridge N. P. R. R.; Henry D. Blunden, First Assistant Engineer Erie Railway; William H. Wiley, of Wiley & Sons, Publishers; Henriques Harris, Engineer Manhattan Beach Railway; Jas. McCrea, Supt. N. Y. Div. Pennsylvania R. R.; Julius W. Adams, Past President A. S. C. E., ENGINEERING NEWS; E. S. Chesbrough, Consulting Engineer New York City; Thomas M. Cleeman, Philadelphia; Joseph P. Davis, Vice-President and Chief Engineer Metropolitan Telephone Co., New York; Prof. T. Egleston, Columbia College, New York; Charles E. Emery, Engineer New York Steam-Heating Co., New York; Bryant Godwin, New York City; Wm. H. Grant, New York City; Wm. E. Hutton, New York; Gabriel Leverich, Brooklyn; Charles Macdonald, President Delaware Bridge Co.; Cook Talcott, Newark, N. J.; Charles D. Ward, Jersey City; W. E. Worthen, New York City; Charles Ward Raymond, Assistant Engineer Hudson River Tunnel; Sebastian Wimmer, New York City; Edward R. Andrews, New York City; John Avery, Assistant Engineer Bureau of Sewers, Department Public Works, New York City; Wm. M. Allaire, New York City; T. H. Aldrich, Birmingham, Ala.; N. H. Atwood, Jersey City, N. J.; Prof. Cleveland Abbe, Washington, D. C.; H. Bissell, Master of Maintenance Eastern Railroad, Salem, Mass.; E. W. Bowditch, Boston, Mass.; Henry R. Bradbury, New York City; Van Brunt Bergen, Assistant Engineer Board of City Works, Brooklyn, N. Y.; Charles O. Brown, New York City; James A. Burden, Burden Iron Works, Troy, N. Y.; William D. Bullock, Assistant City Engineer, Providence, R. I.; Thomas J. Bush, Lexington, Ky.; H. Wadsworth Clarke, Engineer in charge New York and Pennsylvania Boundary Survey, Syracuse, N. Y.; Prof. A. G. Compton, New York City; T. E. Brown, Jr., New York City; Prof. William H. Burr, Rensselaer Institute, Troy, N. Y.; E. A. Doane, Oswego, N. Y.; Edward B. Dorsey, New York City; S. Clarence Ellis, Assistant City Engineer, Boston, Mass.; N. W. Ellis, Manchester, N. H.; Robert Escobar, Delaware Bridge Company, New York City; Charles H. Fisher, Chief Engineer New York Central & Hudson River Railroad, Albany, N. Y.; C. F. Findlay, London, Eng.; Albert Fink, Past President A. S. C. E., New York City; M. N. Forney, *Railroad Gazette*, New York City; Charles E. Goad, Montreal, Can.; George S. Greene, Jr., New York City; E. E. Glaskin, London, Eng.; S. S. Haight, Topograhical Department, New York City; W. G. Hamilton, New York City; A. R. Haddock, New York City; Geo. E. Harding, Chief Engineer New York & Brighton Beach R. R., New York City; B. D. Hasell, General Agent, Great Southern Line, New York City; Wm. A. Haven, Engineer in charge Buffalo Division N. Y., L. O. & W. R. R., Buffalo, N. Y.; Walter Katte, Chief Engineer N. Y., Ontario & Western R. R., New York City; A. P. Kirtland, Blairsville, Pa.; T. H. McKenzie, Southington, Conn.; T. C. McCollon, New London, Conn.; W. H. Martin, San Francisco, Cal.; J. McNulty, Brooklyn, N. Y.; N. Morton, Plymouth, Mass.; J. G. Macklin, Ottawa, Canada; Arthur Macy, New York City; Prof. H. B. Nason, Troy, N. Y.; Isaac Newton, Chief Engineer Croton Aqueduct, New York City; James Owen, Chief Engineer Essex Board, Newark, N. J.; Chas. Paine, Gen. Manager New York, Ontario & Western R. R., New York City; J. C. Platt, Jr., Waterford, N. Y.; J. G. Sanderson, New York City; Robt. P. Staats, New York City; C. V. Smith, Chief Engineer Manhattan Gas Light Company, New York City; S. H. Shreve, Chief Engineer Elevated R. R., Brooklyn, N. Y.; W. W. C. Sites, Jersey City, N. J.; Albert Spies, New York City; A. M. De Souza, Brazil; Joseph R. Thomas, Brooklyn, N. Y.; Prof. R. H. Thurston, Stevens Institute, Hoboken, N. J.; E. B. Van Winkle, Director Topographical Department Public Works, New York City; Robt. Van Buren, City Engineer, Brooklyn, N. Y.; Ashbel Welch, President A. S. C. E., Lambertville, N. J.; John A. Wilson, Philadelphia, Pa.; H. F. Walling, U. S. Coast Survey, Washington, D. C.; Prof. Wm. Watson, Boston, Mass.; L. B. Ward, Jersey City, N. J.; T. J. Whitman, Water Commissioner St. Louis, Mo.; Prof. D. Volson Wood, Stevens Institute, Hoboken, N. J.; James P. Bogart, Hartford, Conn.

THE MICHIGAN ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS.

The second annual meeting of the above Association was held at Lansing on the 12th, 13th and 14th insts. About fifty members were in attendance. Prof. C. E. Greene read a paper on "Deep-Water Foundations;" Prof. R. C. Carpenter read one on "Draining Engineering;" H. C. Pearsons, on "Correction of Compass in Ships;" G. L. Pearsons, "Water-Works for Small Towns," and J. H. Leavenworth, on "Questions of Practice." Problems relating to subdivision of a section, lost corners, etc., etc., were discussed. Financially the Association is in good condition, there being over 100 paying members. The proceedings of the meeting, including the papers read, will soon be issued in pamphlet form, and will be for sale at ten cents per copy. The officers' elected for the following year are: President, Prof. Charles E. Greene, University of Michigan, Ann Arbor; Vice-Presidents, James Sanderson, Detroit; J. K. Yocum, Waterloo; C. M. C. Swoon, Jackson; F. Hodgman, Climax; H. C. Pearsons, Ferrysburg; H. D. Bartholomew, Lansing; J. J. Watkins, Lapeer; C. F. Gould, Saginaw; George E. Steele, Elk Rapids; Secretary and Treasurer, Prof. R. C. Carpenter, Lansing; Executive Committee, William Donovan, Lansing; Burton Kent, Adrian; M. Bullock, Howell; President and Secretary, *ex-officio*.

Special committee on manual continued as last year.

Resolutions of respect were adopted in regard to the late Lyman Mason, engineer on the Mackinaw Division of the Michigan Central Railroad.

It was voted to hold an exhibition of surveyors' and engineers' instruments in connection with the next regular meeting.

ENGINEERS' CLUB OF PHILADELPHIA.

ROOMS NO. 1,523 CHESTNUT STREET, PHILADELPHIA, PA.

Record of regular meeting, Jan. 21, 1882, President Rudolph Hering in the chair, 16 members present:

A paper by Prof. W. S. Chaplin, on the "Relative Tensile Strengths of Long and Short Bars," was presented, on his behalf, by Prof. L. M. Haupt. The object of this paper is to prove that long bars are, on the average, weaker to resist tensile stress than short bars of the same material and cross section, and to show how the reduction in strength may be found when the proper experiments have been made on the short bars.

The Secretary presented a correspondence, in the year 1839, upon the subject of street paving, between the Chairman of the Committee on Public Highways, of the city of Philadelphia, and Mr. Thomas U. Walter, Honorary Member of the Club, who was then in Europe, and was requested to furnish information as to the paving of European cities. His letter treats of the ordinary cobble-stone, wooden, granite-block, cobble-stone with flag-stone tramways, McAdamized and natural and artificial asphaltum roadways, and is remarkable as exhibiting how much was known upon this subject over forty years ago and how little we have profited by it in Philadelphia.

Mr. D. H. Shedaker submitted an extract, giving account of an exhibition of electric lighting in Trafalgar Square, London, in 1848. The results were so satisfactory that the writer considered that "after a short time we should not be surprised to hear of the total extinction of half the gas companies in the kingdom."

Mr. Charles A. Ashburner explained some difficulties which have been encountered in the anthracite coal mines of Schuylkill County, where the coal beds have been "pinched out" and lost, but which have afterwards been found by driving tunnels at right angles to the strike of the beds and away from the center of the basin. This irregularity of structure seems to have been produced by a folding of the strata at right angles to the strike, by a force exerted in the direction of the basin.

HOWARD MURPHY, Secretary and Treasurer.

THE RAIL MARKET.—The *Iron Age's* Philadelphia report says of steel rails: "It is difficult to report this branch of business correctly. There is a general impression that a good many parties have bought more than they are likely to require, and that resales or postponements of deliveries will have to be arranged. Manufacturers in this vicinity assure us that so far as they are concerned they have more buyers than they can accommodate, and that sales at $58 to $60 can be effected without any difficulty whatever. Iron rails are quoted at $48 per ton at mill for heavy rails and $50@$53 for light sections. No large transactions are reported. Spikes are unchanged at $3.15@$3.25 per 100 lbs.; fish-plates $2.60, and track-bolts $3.75@$4.25. Steel blooms are quoted at $46@$46.50 per ton, duty paid, with unsettled market and downward tendency. Old iron rails are a little more active but irregular, at, say, $29@$31.50 per ton in Philadelphia."